



Antenna Composite Gain Test Report

FCC ID	2AHKM-CODA5814Q1
Equipment	DOCIS 3.1 Wi-Fi 6 EMTA Gateway
Brand Name	Hitron
Model Name	CODA5814Q, CODA5810Q
Applicant	Hitron Technologies Inc. No. 1-8, Li-Hsin 1st Rd. Hsinchu Science Park, Hsinchu 30078, Taiwan
Manufacturer	Hitron Technologies Inc. No. 1-8, Li-Hsin 1st Rd. Hsinchu Science Park, Hsinchu 30078, Taiwan
Sample Received	Jun. 28, 2022
Start Test Date	Oct. 25, 2022
Final Test Date	Oct. 25, 2022

Approved by: Sam Chen

Sporton International Inc. Hsinchu Laboratory

No.8, Ln. 724, Bo'ai St., Zhubei City, Hsinchu County 302010, Taiwan (R.O.C.)



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1. Operation Mode and Antenna Information

Antenna Position	RF Port	Brand Name	Model Name	Ant. Type	Connector	Modes of Operation
Ant1	1	Airgain	N03HTAFE-PK1-LA1X80BUR2	PCB Antenna	I-PEX	2.4GHz, 5GHz UNII 1~4
Ant2	2	Airgain	N03HTAFF-PK1-LB1X90BU	PCB Antenna	I-PEX	2.4GHz, 5GHz UNII 1~4
Ant3	3	Airgain	N03HTAFG-PK1-LG1X130BUR2	PCB Antenna	I-PEX	2.4GHz, 5GHz UNII 1~4
Ant4	4	Airgain	N03HTAFH-PK1-LW1X150BU	PCB Antenna	I-PEX	2.4GHz, 5GHz UNII 1~4

Note:

2.4GHz and 5GHz UNII 1~4 Operation Mode (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
5850-5895	5885

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	23.5-24.5 / 45-55	Oct. 25, 2022

Note:

Testing Site Information

Brand Name: TDK

Dimension: 11m*6m*6m

Characteristic: Fully Anechoic Chamber

4. Test Facility and Configuration

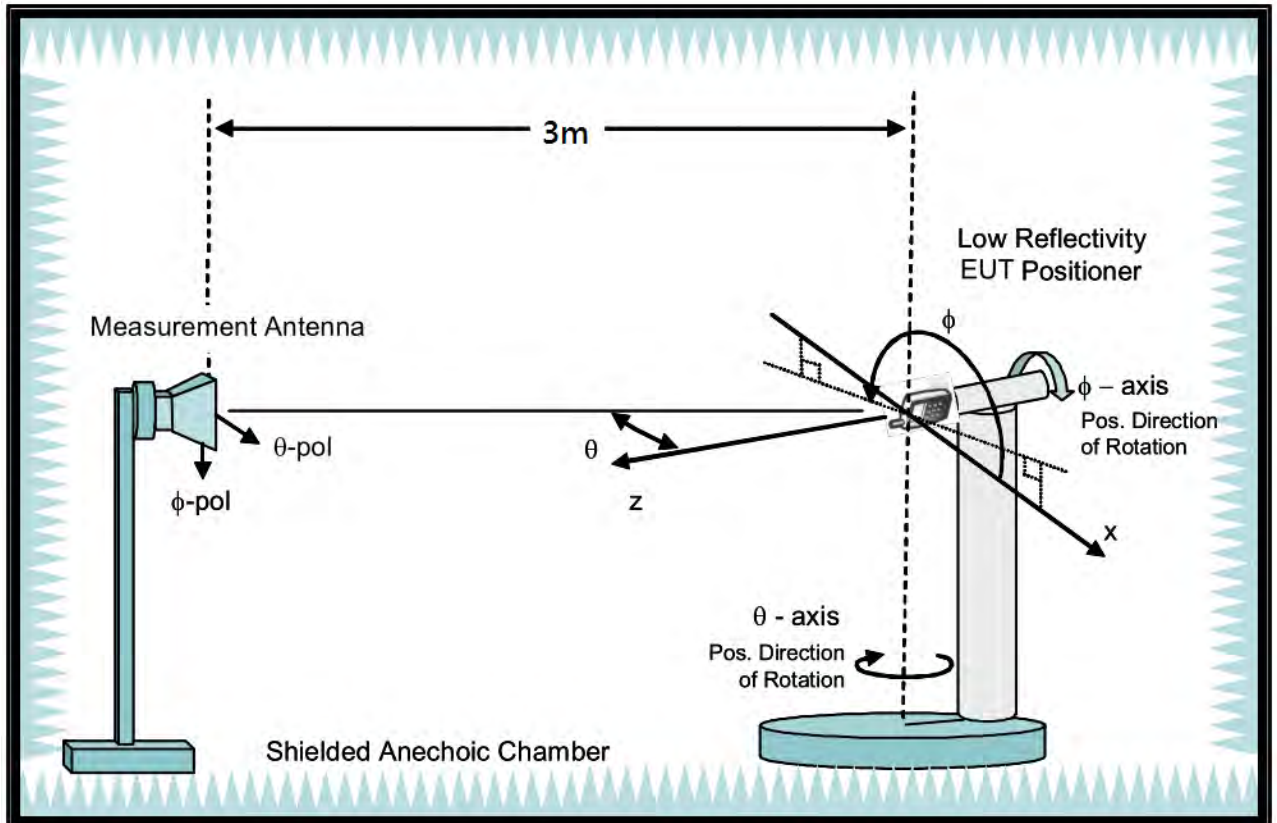
Test configuration: Reference to CITA OTA distributed-axes system configuration.

Chamber: Fully Anechoic Chamber.

Measurement antenna: Dual Polarization Horn antenna

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

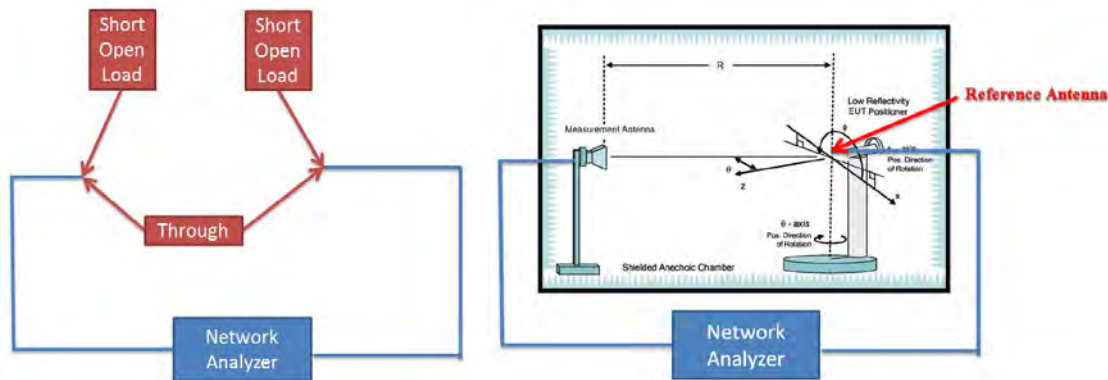
#Reference to CTIA "ctia-test-plan-for-wireless-device-over-the-air-performance-ver-3-7-1"



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	7200
G(theta) reading (dB)	-33.55	-33.27	-32.92	-32.91	-32.73	-32.02	-32.67	-32.82	-32.98	-33.18	-32.8	-33.92	-34.62	-35.57
G(phi) reading (dB)	-33.15	-32.7	-32.41	-32.61	-32.43	-31.72	-32.37	-32.51	-32.52	-32.66	-32.5	-33.62	-34.32	-35.48
Reference gain (dBi)	10.1	10.4	10.7	12.5	12.7	13.5	13.4	13.3	13.3	13.2	13.4	12.5	12.1	11.4
Factor(theta) (dB)	43.65	43.67	43.62	45.41	45.43	45.52	46.07	46.12	46.28	46.38	46.2	46.42	46.72	46.97
Factor(phi) (dB)	43.25	43.1	43.11	45.11	45.13	45.22	45.77	45.81	45.82	45.86	45.9	46.12	46.42	46.88

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 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

DG_1SS max value position

Frequency (Hz)	2.45G	5.2G	5.3G	5.6G	5.785G	5.885G
Ant. 1 (dBi)	1.69	0.15	1.31	-3.1	-2.03	-0.45
Ant. 2 (dBi)	-3.32	-5.57	-3.5	3.25	2.81	3.07
Ant. 3 (dBi)	-4.33	-1.77	0.84	1.69	1.81	1.34
Ant. 4 (dBi)	3.22	2.82	1.69	-1.53	-2.98	-3
DG [1SS] (dBi)	5.92	5.44	6.34	6.46	6.27	6.54
Polarization	Theta	Theta	Theta	Theta	Theta	Theta
$\Theta(^{\circ})$	90	105	97.5	82.5	82.5	82.5
$\Phi(^{\circ})$	105	120	120	285	285	285

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	5.885G
Ant. 1 [$10^{(G/20)}$]	$10^{(1.69/20)}$	$10^{(0.15/20)}$	$10^{(1.31/20)}$	$10^{(-3.1/20)}$	$10^{(-2.03/20)}$	$10^{(-0.45/20)}$
Ant. 2 [$10^{(G/20)}$]	$10^{(-3.32/20)}$	$10^{(-5.57/20)}$	$10^{(-3.5/20)}$	$10^{(3.25/20)}$	$10^{(2.81/20)}$	$10^{(3.07/20)}$
Ant. 3 [$10^{(G/20)}$]	$10^{(-4.33/20)}$	$10^{(-1.77/20)}$	$10^{(0.84/20)}$	$10^{(1.69/20)}$	$10^{(1.81/20)}$	$10^{(1.34/20)}$
Ant. 4 [$10^{(G/20)}$]	$10^{(3.22/20)}$	$10^{(2.82/20)}$	$10^{(1.69/20)}$	$10^{(-1.53/20)}$	$10^{(-2.98/20)}$	$10^{(-3/20)}$
Ant. 1 [$10^{(G/20)}$] value	1.215	1.017	1.163	0.7	0.792	0.95
Ant. 2 [$10^{(G/20)}$] value	0.682	0.527	0.668	1.454	1.382	1.424
Ant. 3 [$10^{(G/20)}$] value	0.607	0.816	1.102	1.215	1.232	1.167
Ant. 4 [$10^{(G/20)}$] value	1.449	1.384	1.215	0.838	0.71	0.708
Sum All Antenna [Amax]	3.953	3.743	4.147	4.207	4.115	4.248
DG [$10 \cdot \log(A_{max}^2/N_{ant})$]	5.92	5.44	6.34	6.46	6.27	6.54

Note:

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

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



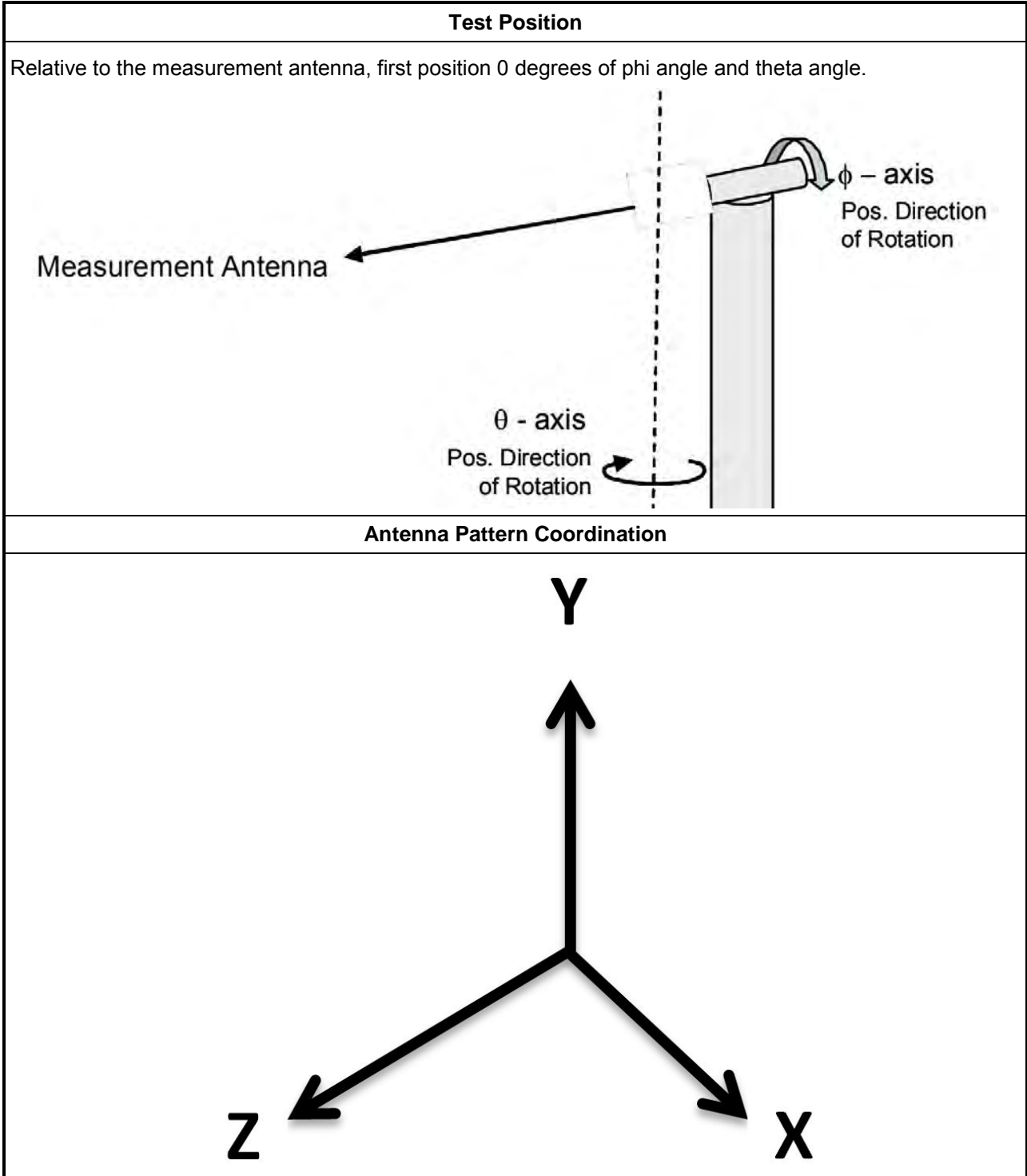
8. Summary of Test Result

Frequency (Hz)	2.45G	5.2G	5.3G	5.6G	5.785G	5.885G
Ant. 1 Max Gain (dBi)	3.13	2.72	2.24	2.67	2.28	2.95
Ant. 2 Max Gain (dBi)	1.42	2.14	2.8	3.46	3.95	4.03
Ant. 3 Max Gain (dBi)	3.4	2.82	2.58	1.87	3.38	3.3
Ant. 4 Max Gain (dBi)	3.26	2.82	3.83	3.78	4.93	5.47
Ant. 1 Polarization/ Θ ($^{\circ}$)/ Φ ($^{\circ}$)	Theta/90/82.5	Phi/150/112.5	Theta/112.5/ 127.5	Theta/112.5/ 127.5	Theta/120/ 127.5	Phi/37.5/120
Ant. 2 Polarization/ Θ ($^{\circ}$)/ Φ ($^{\circ}$)	Phi/120/217.5	Theta/67.5/ 202.5	Theta/67.5/195	Theta/75/285	Theta/82.5/ 300	Theta/82.5/300
Ant. 3 Polarization/ Θ ($^{\circ}$)/ Φ ($^{\circ}$)	Phi/127.5/225	Theta/82.5/300	Theta/82.5/ 292.5	Phi/15/90	Theta/82.5/ 247.5	Theta/82.5/240
Ant. 4 Polarization/ Θ ($^{\circ}$)/ Φ ($^{\circ}$)	Theta/82.5/105	Theta/105/120	Theta/105/ 127.5	Theta/127.5/ 22.5	Theta/127.5/ 22.5	Theta/127.5/ 22.5
Max Gain (dBi)	3.4	2.82	3.83	3.78	4.93	5.47
DG [1SS] (dBi)	5.92	5.44	6.34	6.46	6.27	6.54
DG [2SS] (dBi)	3.4	2.82	3.83	3.78	4.93	5.47
DG [4SS] (dBi)	3.4	2.82	3.83	3.78	4.93	5.47

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)
4. Directional Gain (4SS) = Directional Gain (1SS) – 6dB. 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 31, 2022	May. 30, 2023
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	V1.0.8	-	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.

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Freq(Hz)	2.45G	5.2G	5.3G	5.6G	5.785G	5.885G
Ant. 1 Max Gain (dBi)	3.13	2.72	2.24	2.67	2.28	2.95
Ant. 2 Max Gain (dBi)	1.42	2.14	2.8	3.46	3.95	4.03
Ant. 3 Max Gain (dBi)	3.4	2.82	2.58	1.87	3.38	3.3
Ant. 4 Max Gain (dBi)	3.26	2.82	3.83	3.78	4.93	5.47
Ant. 1 Polarization/ $\theta(^{\circ})/\phi(^{\circ})$	Theta/90/82.5	Phi/150/112.5	Theta/112.5/127.5	Theta/112.5/127.5	Theta/120/127.5	Phi/37.5/120
Ant. 2 Polarization/ $\theta(^{\circ})/\phi(^{\circ})$	Phi/120/217.5	Theta/67.5/202.5	Theta/67.5/195	Theta/75/285	Theta/82.5/300	Theta/82.5/300
Ant. 3 Polarization/ $\theta(^{\circ})/\phi(^{\circ})$	Phi/127.5/225	Theta/82.5/300	Theta/82.5/292.5	Phi/15/90	Theta/82.5/247.5	Theta/82.5/240
Ant. 4 Polarization/ $\theta(^{\circ})/\phi(^{\circ})$	Theta/82.5/105	Theta/105/120	Theta/105/127.5	Theta/127.5/22.5	Theta/127.5/22.5	Theta/127.5/22.5
Max Gain (dBi)	3.4	2.82	3.83	3.78	4.93	5.47
DG [1SS] (dBi)	5.92	5.44	6.34	6.46	6.27	6.54
DG [2SS] (dBi)	3.4	2.82	3.83	3.78	4.93	5.47
DG [4SS] (dBi)	3.4	2.82	3.83	3.78	4.93	5.47



DG 1SS Result

Table with columns for Frequency (Freq/Hz), Polarization (Pol), and various Gain Data points (DG) for different angles and frequencies. The table is organized into sections for 2.45G and 5.2G frequencies, with multiple columns for each angle (Theta) and its corresponding gain values.



Table with columns for frequency (MHz), gain (dB), and various theta/phi angle combinations. The table contains multiple rows of data for different frequencies and angle pairs.



Gain Result

Table with 28 columns and 100 rows of gain data. Columns include Freq(Hz), Gain, and various antenna configurations. Rows include gain data for 2.45GPol and 5.2GPol antennas across various frequencies and antenna types.



Radiated Composite Gain Data

Appendix A

Table with multiple columns showing gain data for various frequencies (e.g., 2.39-1.9, 2.51-1.88, etc.) and different antenna types. Includes sub-tables for 5.6G Pol and 5.785G Pol.



Radiated Composite Gain Data

Appendix A

Table with columns for frequency (MHz), gain (dBi), and various antenna configurations. The table contains multiple rows of data for different frequencies and gain values.



Radiated Composite Gain Data

Appendix A

Main data table containing radiated composite gain data across various frequencies and antenna configurations. The table is organized into four major sections based on frequency: 5.885G Pol, 2.45G Pol, 2.45G Pol, and 2.45G Pol. Each section contains a grid of data points for multiple angles (Theta) and various antenna gain configurations.



Radiated Composite Gain Data

Appendix A

Theta (°)	9.64-9.56	9.97-11.05	12.54-13.03	12.34-12.75	15.77-17.53	11.75-17.37	4.91-3.62	3.03-3.04	3.48-4.44	5.41-5.05	3.37-1.8	-1.0-9.2	-1.39-2.2	-3.18-4.3	-5.4-6.7	-7.78-9.45	-11.11-10.92	-8.75-6.43	-4.68-3.56	-3.06-3.07	-3.59-6.63	-6.11-7.56	-8.62-9.2	-9.69-9.97
Phi (°)	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
Gain (dBi)	Phi(0°)Phi(7.5°)	Phi(7.5°)Phi(15°)	Phi(15°)Phi(22.5°)	Phi(22.5°)Phi(30°)	Phi(30°)Phi(37.5°)	Phi(37.5°)Phi(45°)	Phi(45°)Phi(52.5°)	Phi(52.5°)Phi(60°)	Phi(60°)Phi(67.5°)	Phi(67.5°)Phi(75°)	Phi(75°)Phi(82.5°)	Phi(82.5°)Phi(90°)	Phi(90°)Phi(97.5°)	Phi(97.5°)Phi(105°)	Phi(105°)Phi(112.5°)	Phi(112.5°)Phi(120°)	Phi(120°)Phi(127.5°)	Phi(127.5°)Phi(135°)	Phi(135°)Phi(142.5°)	Phi(142.5°)Phi(150°)	Phi(150°)Phi(157.5°)	Phi(157.5°)Phi(165°)	Phi(165°)Phi(172.5°)	Phi(172.5°)Phi(180°)
Theta (°)	9.64-9.56	9.97-11.05	12.54-13.03	12.34-12.75	15.77-17.53	11.75-17.37	4.91-3.62	3.03-3.04	3.48-4.44	5.41-5.05	3.37-1.8	-1.0-9.2	-1.39-2.2	-3.18-4.3	-5.4-6.7	-7.78-9.45	-11.11-10.92	-8.75-6.43	-4.68-3.56	-3.06-3.07	-3.59-6.63	-6.11-7.56	-8.62-9.2	-9.69-9.97
Phi (°)	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
Gain (dBi)	Phi(0°)Phi(7.5°)	Phi(7.5°)Phi(15°)	Phi(15°)Phi(22.5°)	Phi(22.5°)Phi(30°)	Phi(30°)Phi(37.5°)	Phi(37.5°)Phi(45°)	Phi(45°)Phi(52.5°)	Phi(52.5°)Phi(60°)	Phi(60°)Phi(67.5°)	Phi(67.5°)Phi(75°)	Phi(75°)Phi(82.5°)	Phi(82.5°)Phi(90°)	Phi(90°)Phi(97.5°)	Phi(97.5°)Phi(105°)	Phi(105°)Phi(112.5°)	Phi(112.5°)Phi(120°)	Phi(120°)Phi(127.5°)	Phi(127.5°)Phi(135°)	Phi(135°)Phi(142.5°)	Phi(142.5°)Phi(150°)	Phi(150°)Phi(157.5°)	Phi(157.5°)Phi(165°)	Phi(165°)Phi(172.5°)	Phi(172.5°)Phi(180°)
Theta (°)	17.88-18.86	13.01-9.54	-8.62-5.11	4.19-3.33	2.51-1.65	-1.44-1.56	-1.32-1.38	-1.89-2.62	-3.67-4.94	-6.71-8.81	-11.83-14.84	-13.8-11.28	-8.67-6.51	4.91-3.65	2.77-2.02	-1.51-1.04	-0.83-0.58	-0.39-0.43	-0.76-1.05	-1.24-1.7	-2.42-3.41	-4.71-6.77	-9.35-11.75	-14.79-17.68
Phi (°)	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
Gain (dBi)	Phi(0°)Phi(7.5°)	Phi(7.5°)Phi(15°)	Phi(15°)Phi(22.5°)	Phi(22.5°)Phi(30°)	Phi(30°)Phi(37.5°)	Phi(37.5°)Phi(45°)	Phi(45°)Phi(52.5°)	Phi(52.5°)Phi(60°)	Phi(60°)Phi(67.5°)	Phi(67.5°)Phi(75°)	Phi(75°)Phi(82.5°)	Phi(82.5°)Phi(90°)	Phi(90°)Phi(97.5°)	Phi(97.5°)Phi(105°)	Phi(105°)Phi(112.5°)	Phi(112.5°)Phi(120°)	Phi(120°)Phi(127.5°)	Phi(127.5°)Phi(135°)	Phi(135°)Phi(142.5°)	Phi(142.5°)Phi(150°)	Phi(150°)Phi(157.5°)	Phi(157.5°)Phi(165°)	Phi(165°)Phi(172.5°)	Phi(172.5°)Phi(180°)



Radiated Composite Gain Data

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	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
Φ(0°)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
Φ(7.5°)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	



Frequency (MHz)	Theta (°)	Freq(Hz)	Theta (°)	Freq(Hz)	Theta (°)	Freq(Hz)	Theta (°)	Freq(Hz)	Theta (°)	Freq(Hz)	Theta (°)	Freq(Hz)	Theta (°)	Freq(Hz)	Theta (°)	Freq(Hz)	Theta (°)	Freq(Hz)	Theta (°)	Freq(Hz)	Theta (°)	Freq(Hz)	Theta (°)	Freq(Hz)	Theta (°)	Freq(Hz)	Theta (°)	Freq(Hz)	Theta (°)																								
142.5	-10.93-14.63	142.5	-16.72-13.11	142.5	-16.14-19.44	142.5	-6.33-5.83	142.5	-8.91-11.99	142.5	-13.83-8.41	142.5	-5.29-4.52	142.5	-5.27-6.72	142.5	-5.42-5.84	142.5	-8.1-8.95	142.5	-10.46-11.34	142.5	-8.59-8.51	142.5	-14.65-15.79	142.5	-10.54-10.31	142.5	-9.73-9.71	142.5	-9.53-9.19	142.5	-4.32-13.01	142.5	-6.99-4.03	142.5	-1.59-9.67	142.5	-5.64-4.93	142.5	-11.92-15.48	142.5	-12.33-16.92	142.5	-17.67-14.86	142.5	-17.38-17.48						
150	-6.07-7.26	150	-13.69-18.13	150	-17.26-16.05	150	-9.44-6.28	150	-5.87-7.07	150	-6.33-4.54	150	-4.16-5.17	150	-6.52-6.92	150	-6.82-6.62	150	-8.22-7.98	150	-12.08-11.82	150	-18.42-16.34	150	-18.95-17.03	150	-13.2-13.88	150	-15.4-12.74	150	-7.46-6.28	150	-9.35-11.54	150	-8.57-5.68	150	-6.63-12.43	150	-16.35-9.95	150	-8.46-11.22	150	-12.82-15.22	150	-18.56-17.43	150	-11.82-7.41						
157.5	-5.37-6.42	157.5	-7.83-8.58	157.5	-10.66-17.87	157.5	-19.08-14.18	157.5	-13.73-12.72	157.5	-9.74-8.45	157.5	-7.24-7.01	157.5	-9.07-10.19	157.5	-8.27-7.55	157.5	-8.43-9.34	157.5	-9.32-9.82	157.5	-11.94-14.52	157.5	-10.95-11.23	157.5	-14.39-13.81	157.5	-16.86-18.74	157.5	-18.43-15.55	157.5	-18.77-19.11	157.5	-12.21-8.06	157.5	-10.99-6.78	157.5	-4.46-4.07	157.5	-4.53-4.63	157.5	-5.03-5.99	157.5	-6.02-6.22								
165	-2.89-3.96	165	-5.73-8.21	165	-11.52-15.64	165	-17.45-14.91	165	-12.61-9.22	165	-5.91-4.99	165	-6.09-7.62	165	-8.81-10.81	165	-12.73-14.6	165	-12.62-9.37	165	-7.57-7.71	165	-9.63-14.23	165	-16.12-13.3	165	-12.79-13.89	165	-15.14-17.34	165	-17.43-18.01	165	-17.53-17.72	165	-15.34-12.88	165	-13.01-11.88	165	-9.15-7.03	165	-5.63-5.39	165	-6.43-6.58	165	-5.51-4.21	165	-3.71-3.15						
172.5	-13.19-15.32	172.5	-19.61-17.53	172.5	-18.26-18.81	172.5	-18.75-17.91	172.5	-19.45-15.01	172.5	-10.71-9.34	172.5	-10.11-11.17	172.5	-13.23-18.12	172.5	-17.62-17.78	172.5	-12.91-10.41	172.5	-9.83-9.96	172.5	-10.53-12.11	172.5	-13.67-13.93	172.5	-13.71-15.02	172.5	-17.52-16.86	172.5	-18.04-15.67	172.5	-15.17-14.88	172.5	-15.67-17.37	172.5	-17.79-19.26	172.5	-15.09-12.82	172.5	-11.77-10.87	172.5	-9.47-8.58	172.5	-8.35-8.11	172.5	-9.2-11.76						
180	-10.46-10.55	180	-11.18-12.22	180	-13.48-12.81	180	-12.28-12.63	180	-11.76-11.2	180	-11.79-11.71	180	-13.66-17.22	180	-18.33-18.74	180	-17.66-19.02	180	-18.61-16.42	180	-13.74-11.93	180	-10.17-8.66	180	-7.83-7.41	180	-8.59-9.94	180	-11.73-12.23	180	-12.14-12.17	180	-12.51-12.39	180	-12.32-19.26	180	-13.09-12.9	180	-12.25-11.56	180	-11.11-11.47	180	-11.83-11.05	180	-10.07-10.47								
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)																													



Radiated Composite Gain Data

Appendix A

Freq(Hz)	Theta(°)	Phi(°)	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°)	
5.60GHz	0°	0°	0°	0°	0°	0°	0°	0°	0°	0°	0°	0°	0°	0°	0°	0°	0°	0°	0°	0°	0°	0°	0°	0°	0°	0°	
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°)	
Theta(0°)	-18.73-18.73	-19.07-17.88	-17.52-18.42	-17.95-17.94	-18.26-17.55	-18.14-18.45	-18.23-18.48	-18.13-18.65	-18.04-18.82	-16.05-15.19	-14.81-18.02	-15.68-15.96	-16.47-17.68	-18.19-18.04	-18.59-18.32	-18.73-18.92	-18.63-19.03	-17.41-19.48	-18.37-18.34	-17.58-17.89	-17.08-17.76	-16.81-18.81	-17.52-17.99	-17.08-17.76	-19.19-19.31	-19.31-19.31	-19.31-19.31



Table with columns for frequency (MHz), gain, and various theta and phi angles. The table contains numerical data for each combination of these parameters.



Total Gain Data

Table with 27 columns and multiple rows, containing gain data for various frequencies and antenna configurations. Headers include Freq(Hz), TotalAnt, and Gain for various frequencies from 2.45GHz to 5.785GHz.



Table with columns for frequency (MHz/Hz), total antenna gain, and gain in various directions (Theta and Phi). The table contains numerical data for various frequencies and directions.



Table with columns for Azimuth (Theta), Elevation (Phi), and Gain. It contains 20 rows of data for different antenna configurations, with values ranging from -12.30 to 14.82 dB.



Table with 26 columns representing frequency bands and 26 rows representing gain values. The table contains numerical data for various antenna configurations across different frequency ranges.



Table with columns for frequency (Freq), gain, and various antenna pattern values (Theta) for different frequencies and gain levels. The table contains multiple rows of numerical data.

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

