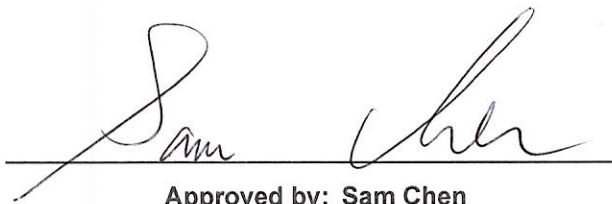




# Antenna Composite Gain Test Report

FCC ID	NKRATTCGW450
Equipment	5G Residential Gateway
Brand Name	WNC
Model Name	CGW450-400
Applicant	Wistron NeWeb Corp. 20 Park Avenue II, Hsinchu Science Park, Hsinchu 308, Taiwan, R.O.C
Manufacturer	NEWEB VIET NAM CO., LTD. Land Lot CN01, Dong Van III Industrial zone, Dong Van Ward, Duy Tien Town, Ha Nam Province, VietNam
Sample Received	Aug. 01, 2022
Start Test Date	Aug. 09, 2022
Final Test Date	Aug. 09, 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.)



## Table of Contents

History of this test report.....	3
1. Operation Mode and Antenna Information .....	4
2. Description for two FCC ID (NKR-ATTCGW450&NKRATTGW450).....	4
3. Test Frequency .....	4
4. Testing Location.....	5
5. Test Facility and Configuration.....	6
6. Reference Calibration .....	7
7. Test Method .....	8
8. Measured Values and Calculation of Maximum Gain Positions.....	9
9. Summary of Test Result .....	10
10. Test Setup .....	11
11. Test Equipment and Calibration Data .....	12
12. Test Results .....	13



### History of this test report

<b>Report No.</b>	<b>Version</b>	<b>Description</b>	<b>Issued Date</b>
AP280117-05	01	Initial issue of report	Mar. 28, 2023
AP280117-05	02	Add the section 2.	Apr. 17, 2023



### 1. Operation Mode and Antenna Information

Antenna Position	RF Port		Brand Name	Model Name	Ant. Type	Connector	Modes of Operation
	2.4GHz	5GHz					
2G5G Ant1	1	1	WNC	48XKAC42	Dipole	I-PEX	2.4GHz & 5GHz UNII 1~3
2G5G Ant2	2	2	WNC	48XKAC3F	Dipole	I-PEX	2.4GHz & 5GHz UNII 1~3
2G5G Ant3	3	3	WNC	48XKAC45	Dipole	I-PEX	2.4GHz & 5GHz UNII 1~3
2G5G Ant4	4	4	WNC	48XKAC46	Dipole	I-PEX	2.4GHz & 5GHz UNII 1~3

Note:

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

2G5G Ant 1~4 can be used as transmitting/receiving antenna.

2G5G Ant 1~4 could transmit/receive simultaneously.

### 2. Description for two FCC ID (NKR-ATTCGW450&NKRATTTCGW450)

Description	FCC ID (NKR-ATTCGW450) of Previously Devices	FCC ID (NKRATTTCGW450) of New Application
6GHz UNII5-8 function	With	Without

Note : The device (FCC ID:NKRATTTCGW450) almost same as the previously device (FCC ID:NKR-ATTCGW450), except above difference. After the Spot check for 2.4GHz and 5GHz, the DG of FCC ID:NKR-ATTCGW450 is also available for FCC ID:NKRATTTCGW450.

### 3. 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



#### 4. 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	23-24 / 40-50	Aug. 09, 2022

Note:

Testing Site Information

Brand Name: TDK

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

Characteristic: Fully Anechoic Chamber

### 5. Test Facility and Configuration

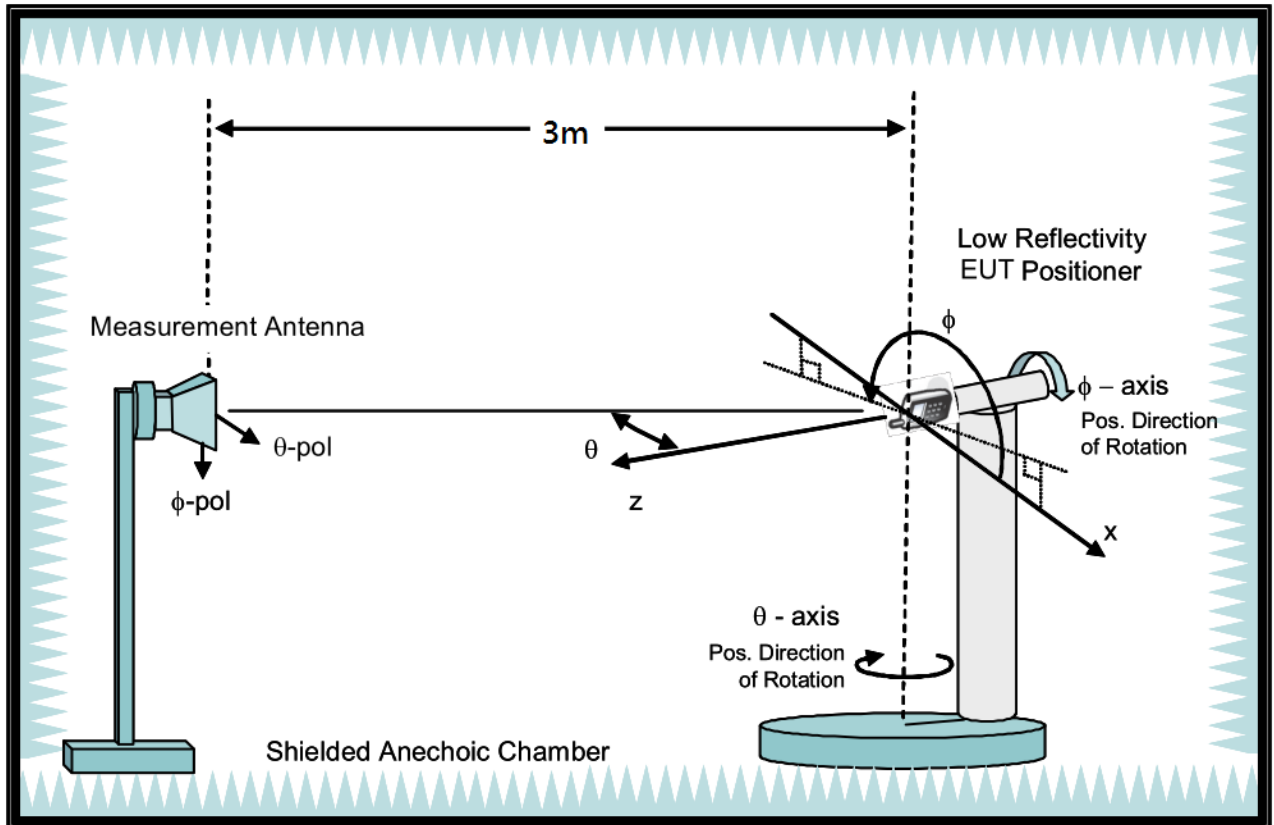
Test configuration: Reference to CITA OTA distributed-axes system configuration.

Chamber: Fully Anechoic Chamber.

Measurement antenna: Dual Polarization Horn antenna

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

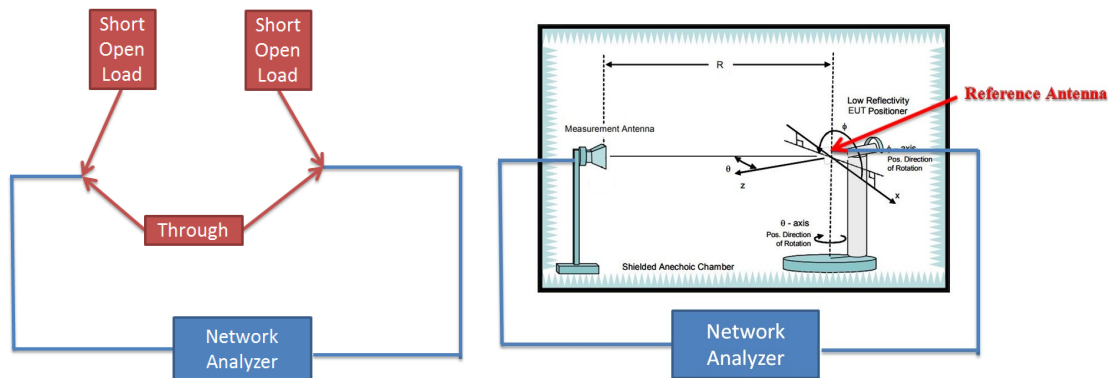
#Reference to CTIA "ctia-test-plan-for-wireless-device-over-the-air-performance-ver-3-7-1"



## 6. 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.

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

## 7. 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 8 tables.

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





### 8. 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)	4.48	4.76	4.19	1.59	2.86
Ant. 2 (dBi)	-6.14	-10.61	-12.12	-12.36	-13.3
Ant. 3 (dBi)	1.92	1.13	-0.04	4.16	4.1
Ant. 4 (dBi)	-3.39	-1.86	1.42	-0.97	-0.23
DG [1SS] (dBi)	6.22	5.96	6.11	5.91	6.41
Polarization	Theta	Theta	Theta	Theta	Theta
$\Theta(^{\circ})$	70	80	90	80	90
$\Phi(^{\circ})$	90	80	80	100	90

Note: The DG 1SS max value position is the maximum value of section 12 table DG 1SS Result.

#### DG\_1SS max value position calculation

Frequency (Hz)	2.45G	5.2G	5.3G	5.6G	5.785G
Ant. 1 [ $10^{(G/20)}$ ]	$10^{(4.48/20)}$	$10^{(4.76/20)}$	$10^{(4.19/20)}$	$10^{(1.59/20)}$	$10^{(2.86/20)}$
Ant. 2 [ $10^{(G/20)}$ ]	$10^{(-6.14/20)}$	$10^{(-10.61/20)}$	$10^{(-12.12/20)}$	$10^{(-12.36/20)}$	$10^{(-13.3/20)}$
Ant. 3 [ $10^{(G/20)}$ ]	$10^{(1.92/20)}$	$10^{(1.13/20)}$	$10^{(-0.04/20)}$	$10^{(4.16/20)}$	$10^{(4.1/20)}$
Ant. 4 [ $10^{(G/20)}$ ]	$10^{(-3.39/20)}$	$10^{(-1.86/20)}$	$10^{(1.42/20)}$	$10^{(-0.97/20)}$	$10^{(-0.23/20)}$
Ant. 1 [ $10^{(G/20)}$ ] value	1.675	1.73	1.62	1.201	1.39
Ant. 2 [ $10^{(G/20)}$ ] value	0.493	0.295	0.248	0.241	0.216
Ant. 3 [ $10^{(G/20)}$ ] value	1.247	1.139	0.995	1.614	1.603
Ant. 4 [ $10^{(G/20)}$ ] value	0.677	0.807	1.178	0.894	0.974
Sum All Antenna [Amax]	4.092	3.971	4.041	3.951	4.183
DG [ $10 \cdot \log(A_{max}^2/N_{ant})$ ]	6.22	5.96	6.11	5.91	6.41

Note:

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

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



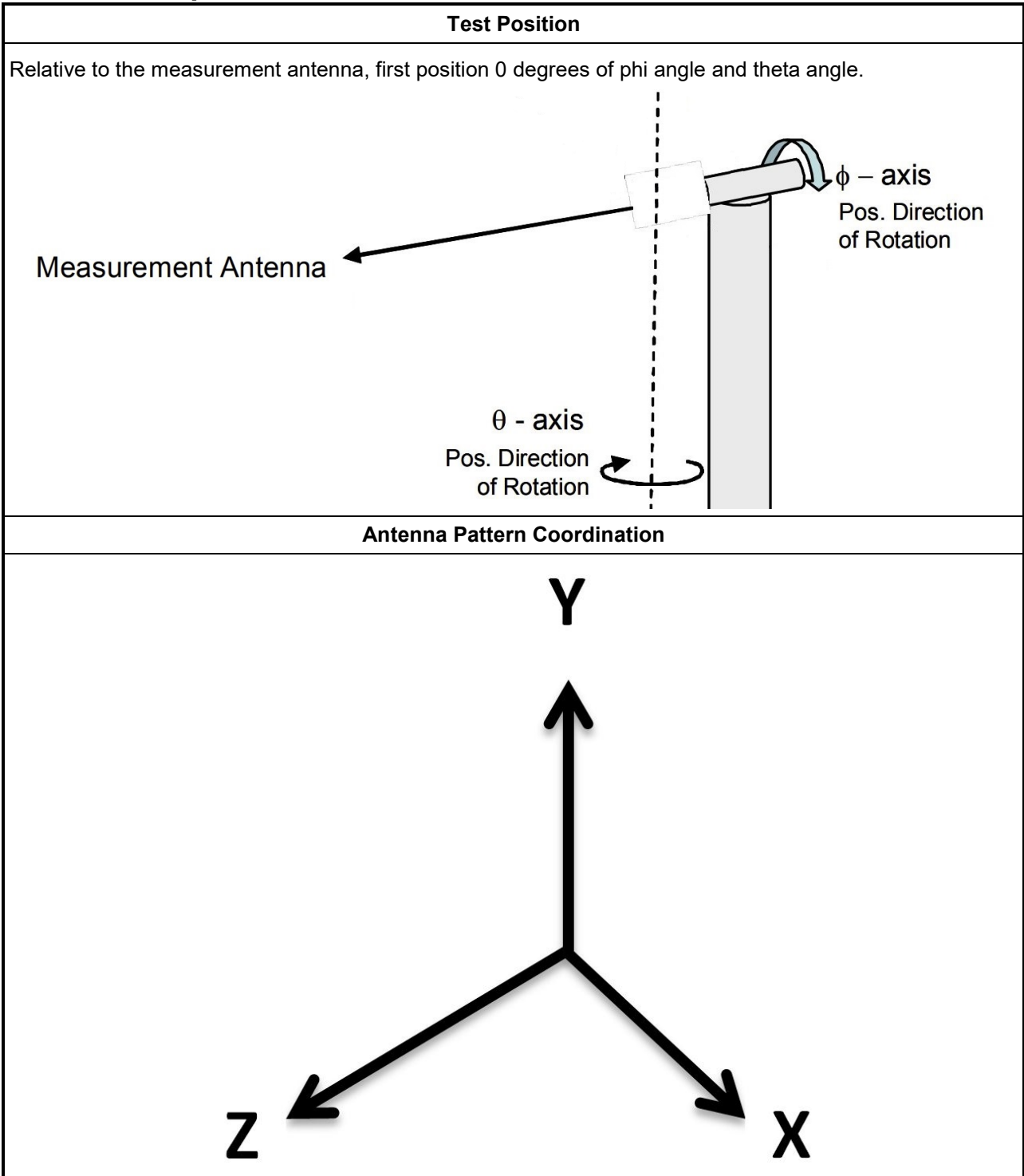
9. Summary of Test Result

Frequency (Hz)	2.45G	5.2G	5.3G	5.6G	5.785G
Ant. 1 Max Gain (dBi)	4.48	4.76	4.98	5.04	4.67
Ant. 2 Max Gain (dBi)	3.97	2.47	3.56	5.02	5.63
Ant. 3 Max Gain (dBi)	3.69	3.02	3.54	4.16	4.1
Ant. 4 Max Gain (dBi)	2.02	2.2	3.17	4.01	3.22
Ant. 1 Polarization/ $\theta(^{\circ})/\Phi(^{\circ})$	Theta/70/90	Theta/80/80	Theta/80/70	Theta/90/70	Theta/90/80
Ant. 2 Polarization/ $\theta(^{\circ})/\Phi(^{\circ})$	Phi/20/80	Phi/80/80	Phi/40/80	Phi/80/100	Phi/80/100
Ant. 3 Polarization/ $\theta(^{\circ})/\Phi(^{\circ})$	Theta/60/80	Theta/80/90	Theta/90/100	Theta/80/100	Theta/90/90
Ant. 4 Polarization/ $\theta(^{\circ})/\Phi(^{\circ})$	Phi/50/90	Theta/100/130	Theta/110/130	Theta/100/140	Theta/100/150
Max Gain (dBi)	4.48	4.76	4.98	5.04	5.63
DG [1SS] (dBi)	6.22	5.96	6.11	5.91	6.41
DG [2SS] (dBi)	4.48	4.76	4.98	5.04	5.63
DG [4SS] (dBi)	4.48	4.76	4.98	5.04	5.63

Note:

1. Antenna max gain is the max value of each individual antenna through all measurement angles. Each antenna max gain is the max value of measurement G of theta and phi 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)
5. The test results quote FCC ID: NKR-ATTCGW450. The difference is removing the 6GHz hardware from FCC ID: NKRATTCGW450.

### 10. Test Setup



Note:

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



### 11. 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.



## **12. Test Results**

Please refer to the appendix.

Appendix A – Radiated Composite Gain.....	Page 13
Appendix B – Antenna Pattern.....	Page 24
Appendix C – Test Photos.....	Page 30



Freq(Hz)	2.45G	5.2G	5.3G	5.6G	5.785G
Ant. 1 Max Gain (dBi)	4.48	4.76	4.98	5.04	4.67
Ant. 2 Max Gain (dBi)	3.97	2.47	3.56	5.02	5.63
Ant. 3 Max Gain (dBi)	3.69	3.02	3.54	4.16	4.1
Ant. 4 Max Gain (dBi)	2.02	2.2	3.17	4.01	3.22
Ant. 1 Polarization/ $\theta(^{\circ})/\Phi(^{\circ})$	Theta/70/90	Theta/80/80	Theta/80/70	Theta/90/70	Theta/90/80
Ant. 2 Polarization/ $\theta(^{\circ})/\Phi(^{\circ})$	Phi/20/80	Phi/80/80	Phi/40/80	Phi/80/100	Phi/80/100
Ant. 3 Polarization/ $\theta(^{\circ})/\Phi(^{\circ})$	Theta/60/80	Theta/80/90	Theta/90/100	Theta/80/100	Theta/90/90
Ant. 4 Polarization/ $\theta(^{\circ})/\Phi(^{\circ})$	Phi/50/90	Theta/100/130	Theta/110/130	Theta/100/140	Theta/100/150
Max Gain (dBi)	4.48	4.76	4.98	5.04	5.63
DG [1SS] (dBi)	6.22	5.96	6.11	5.91	6.41
DG [2SS] (dBi)	4.48	4.76	4.98	5.04	5.63
DG [4SS] (dBi)	4.48	4.76	4.98	5.04	5.63





Radiated Composite Gain Data

Appendix A

Table with columns for angle (Theta), frequency (FREQ), and gain (DG(Db)) for various composite angles and frequencies. Values are provided in dB.



## Gain Result

Freq(Hz)	2.45GPol.	PhiAnt. 1	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-
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°)	
10°	-11.49-9.52	-8.34-7.43	-7.44-7.19	-7.44-7.19	-7.44-7.19	-7.44-7.19	-7.44-7.19	-7.44-7.19	-7.44-7.19	-7.44-7.19	-7.44-7.19	-7.44-7.19	-7.44-7.19	-7.44-7.19	-7.44-7.19	-7.44-7.19	-7.44-7.19	-7.44-7.19	-7.44-7.19



Radiated Composite Gain Data

Appendix A

Table with columns for frequency (Freq), gain, and various antenna configurations. Includes sub-headers for Phi(0) to Phi(360) and ThetaAnt. 1/2.





Radiated Composite Gain Data

Appendix A

Table with columns for frequency (Freq(Hz)), antenna gain (Gain), and radiation patterns for various angles (Theta) from 0 to 140 degrees. It includes data for two different antenna configurations: 5.6GPol and 5.785GPol.













Total Gain Data

Table with 18 columns for frequency (0 to 180 degrees) and 18 rows of gain data for various antenna configurations. Includes sub-sections for 2.45GPol, 5.2GPol, 5.3GPol, and 5.6GPol.



Table with 18 columns representing angles from 0 to 150 degrees and 18 rows representing gain values in dBi. The table contains numerical data for each angle-gain combination, with some cells containing bolded values like 3.95, 5.89, and 5.10. The columns are labeled with angles and the rows with gain values.



Gain	Φ(0°)Φ(10°)	Φ(20°)Φ(30°)	Φ(40°)Φ(50°)	Φ(60°)Φ(70°)	Φ(80°)Φ(90°)	Φ(100°)Φ(110°)	Φ(120°)Φ(130°)	Φ(140°)Φ(150°)	Φ(160°)Φ(170°)	Φ(180°)Φ(190°)	Φ(200°)Φ(210°)	Φ(220°)Φ(230°)	Φ(240°)Φ(250°)	Φ(260°)Φ(270°)	Φ(280°)Φ(290°)	Φ(300°)Φ(310°)	Φ(320°)Φ(330°)	Φ(340°)Φ(350°)
Gain	Φ(0°)Φ(10°)	Φ(20°)Φ(30°)	Φ(40°)Φ(50°)	Φ(60°)Φ(70°)	Φ(80°)Φ(90°)	Φ(100°)Φ(110°)	Φ(120°)Φ(130°)	Φ(140°)Φ(150°)	Φ(160°)Φ(170°)	Φ(180°)Φ(190°)	Φ(200°)Φ(210°)	Φ(220°)Φ(230°)	Φ(240°)Φ(250°)	Φ(260°)Φ(270°)	Φ(280°)Φ(290°)	Φ(300°)Φ(310°)	Φ(320°)Φ(330°)	Φ(340°)Φ(350°)
Gain	Φ(0°)Φ(10°)	Φ(20°)Φ(30°)	Φ(40°)Φ(50°)	Φ(60°)Φ(70°)	Φ(80°)Φ(90°)	Φ(100°)Φ(110°)	Φ(120°)Φ(130°)	Φ(140°)Φ(150°)	Φ(160°)Φ(170°)	Φ(180°)Φ(190°)	Φ(200°)Φ(210°)	Φ(220°)Φ(230°)	Φ(240°)Φ(250°)	Φ(260°)Φ(270°)	Φ(280°)Φ(290°)	Φ(300°)Φ(310°)	Φ(320°)Φ(330°)	Φ(340°)Φ(350°)
Gain	Φ(0°)Φ(10°)	Φ(20°)Φ(30°)	Φ(40°)Φ(50°)	Φ(60°)Φ(70°)	Φ(80°)Φ(90°)	Φ(100°)Φ(110°)	Φ(120°)Φ(130°)	Φ(140°)Φ(150°)	Φ(160°)Φ(170°)	Φ(180°)Φ(190°)	Φ(200°)Φ(210°)	Φ(220°)Φ(230°)	Φ(240°)Φ(250°)	Φ(260°)Φ(270°)	Φ(280°)Φ(290°)	Φ(300°)Φ(310°)	Φ(320°)Φ(330°)	Φ(340°)Φ(350°)
Gain	Φ(0°)Φ(10°)	Φ(20°)Φ(30°)	Φ(40°)Φ(50°)	Φ(60°)Φ(70°)	Φ(80°)Φ(90°)	Φ(100°)Φ(110°)	Φ(120°)Φ(130°)	Φ(140°)Φ(150°)	Φ(160°)Φ(170°)	Φ(180°)Φ(190°)	Φ(200°)Φ(210°)	Φ(220°)Φ(230°)	Φ(240°)Φ(250°)	Φ(260°)Φ(270°)	Φ(280°)Φ(290°)	Φ(300°)Φ(310°)	Φ(320°)Φ(330°)	Φ(340°)Φ(350°)
Gain	Φ(0°)Φ(10°)	Φ(20°)Φ(30°)	Φ(40°)Φ(50°)	Φ(60°)Φ(70°)	Φ(80°)Φ(90°)	Φ(100°)Φ(110°)	Φ(120°)Φ(130°)	Φ(140°)Φ(150°)	Φ(160°)Φ(170°)	Φ(180°)Φ(190°)	Φ(200°)Φ(210°)	Φ(220°)Φ(230°)	Φ(240°)Φ(250°)	Φ(260°)Φ(270°)	Φ(280°)Φ(290°)	Φ(300°)Φ(310°)	Φ(320°)Φ(330°)	Φ(340°)Φ(350°)
Gain	Φ(0°)Φ(10°)	Φ(20°)Φ(30°)	Φ(40°)Φ(50°)	Φ(60°)Φ(70°)	Φ(80°)Φ(90°)	Φ(100°)Φ(110°)	Φ(120°)Φ(130°)	Φ(140°)Φ(150°)	Φ(160°)Φ(170°)	Φ(180°)Φ(190°)	Φ(200°)Φ(210°)	Φ(220°)Φ(230°)	Φ(240°)Φ(250°)	Φ(260°)Φ(270°)	Φ(280°)Φ(290°)	Φ(300°)Φ(310°)	Φ(320°)Φ(330°)	Φ(340°)Φ(350°)



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

