



Antenna Composite Gain Test Report

Equipment	DOCSIS 3.1 Residential Voice Gateway
Brand Name	Technicolor
Model Name	CGA437ATCH5 ; CGA437AXXXX (where X can be alphanumeric, -, or blank)
Applicant	Technicolor Connected Home USA LLC 4855 Peachtree Industrial Blvd. Suite 200 Norcross, Georgia 30092
Manufacturer	Technicolor Connected Home USA LLC 4855 Peachtree Industrial Blvd. Suite 200 Norcross, Georgia 30092
Sample Received	Mar. 30, 2022
Start Test Date	Apr. 06, 2022
Final Test Date	Apr. 07, 2022


Approved by: Jackson Tsai

SPORTON INTERNATIONAL INC. Hsinhua Laboratory

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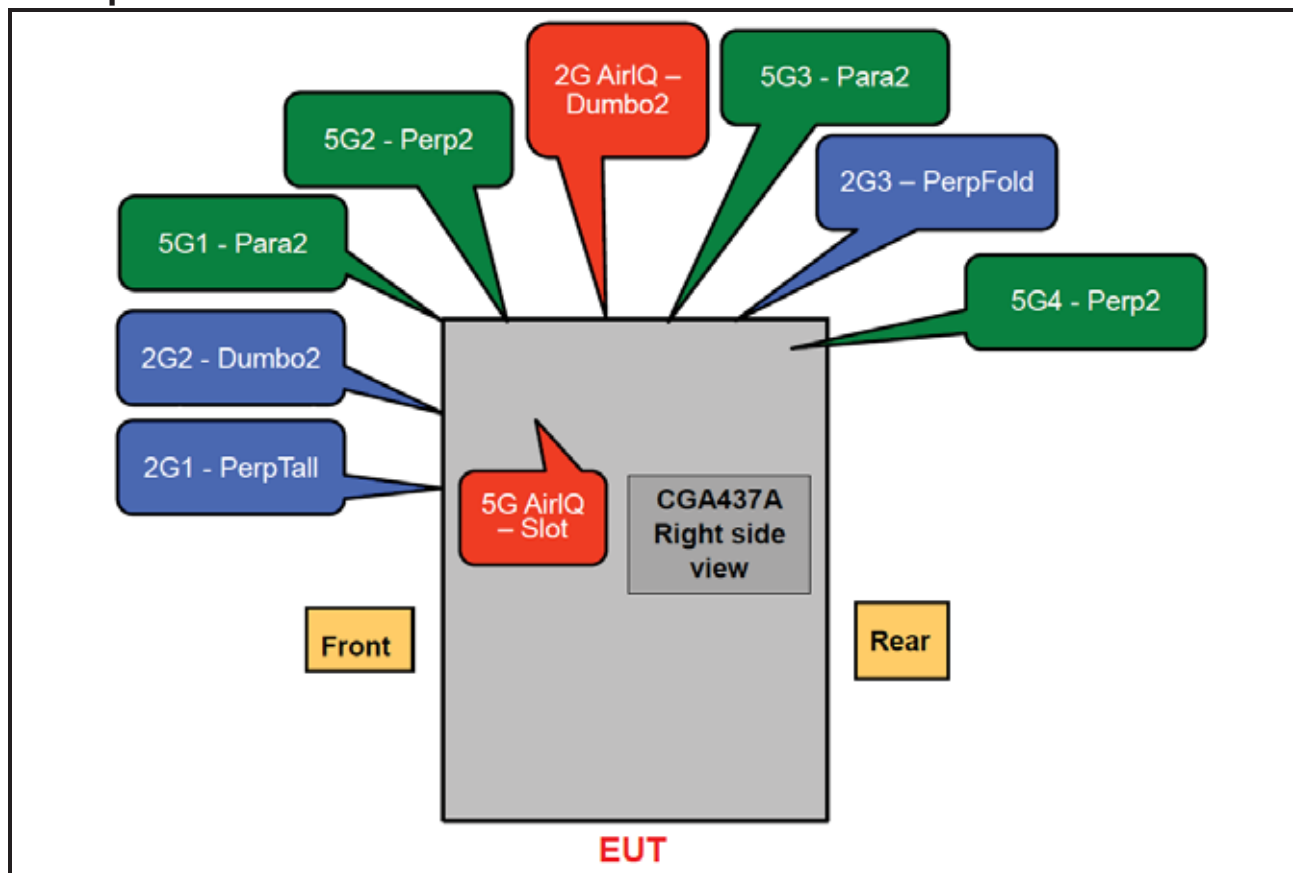
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History of this test report

Report No.	Version	Description	Issued Date
AP232914-01	01	Initial issue of report	Nov. 16, 2022
AP232914-01	02	Revise Antenna Location photo This report is the latest version replacing for the report issued on Nov. 16, 2022	Nov. 22, 2022

1. Operation Mode and Antenna Information



Antenna Position	RF Port	Brand Name	Model Name	Ant. Type	Connector	Modes of Operation
2G1 - PerpTall (Ant1)	1	Technicolor	2G1 - PerpTall	PIFA	I-PEX / UFL	2.4GHz
2G2 - Dumbo2 (Ant2)	2	Technicolor	2G2 - Dumbo2	PIFA	I-PEX / UFL	2.4GHz
2G3 – PerpFold (Ant3)	3	Technicolor	2G3 - PerpFold	PIFA	I-PEX / UFL	2.4GHz
5G1 - Para2 (Ant1)	1	Technicolor	5G1 - Para2	PIFA	I-PEX / UFL	5GHz
5G2 - Perp2 (Ant2)	2	Technicolor	5G2 - Perp2	PIFA	I-PEX / UFL	5GHz
5G3 - Para2 (Ant3)	3	Technicolor	5G3 - Para2	PIFA	I-PEX / UFL	5GHz
5G4 - Perp2 (Ant4)	4	Technicolor	5G4 - Perp2	PIFA	I-PEX / UFL	5GHz

Note:

2.4GHz Operation Mode (3TX/3RX)

2G1 - PerpTall (Ant1) ~ 2G3 – PerpFold (Ant3) could transmit/receive simultaneously.

5GHz Operation Mode (4TX/4RX)

5G1 - Para2 (Ant1) ~ 5G4 - Perp2 (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	2400
2400-2483.5	2450
2400-2483.5	2483.5
5150-5250	5200
5250-5350	5300
5470-5725	5600
5725-5850	5785

3. Testing Location

Test Lab. : Sporton International Inc. Hsinhua Laboratory				
☒ Wen 33rd.St.	ADD:	No.14-1, Ln. 19, Wen 33rd St., Guishan Dist., Taoyuan City 333010, Taiwan (R.O.C.)		
	TEL: 886-3-318-0787	FAX: 886-3-318-0287		
Test Condition	Test Site No.	Test Engineer	Test Environment	Test Date
Radiated	05CH03-HY	Rex Liao	23.5~24.5°C / 40~50%	06/Apr/2022~07/Apr/2022

Note:

Testing Site Information

Brand Name: TDK

Dimension: 11m*6m*6m

Characteristic: Fully Anechoic Chamber

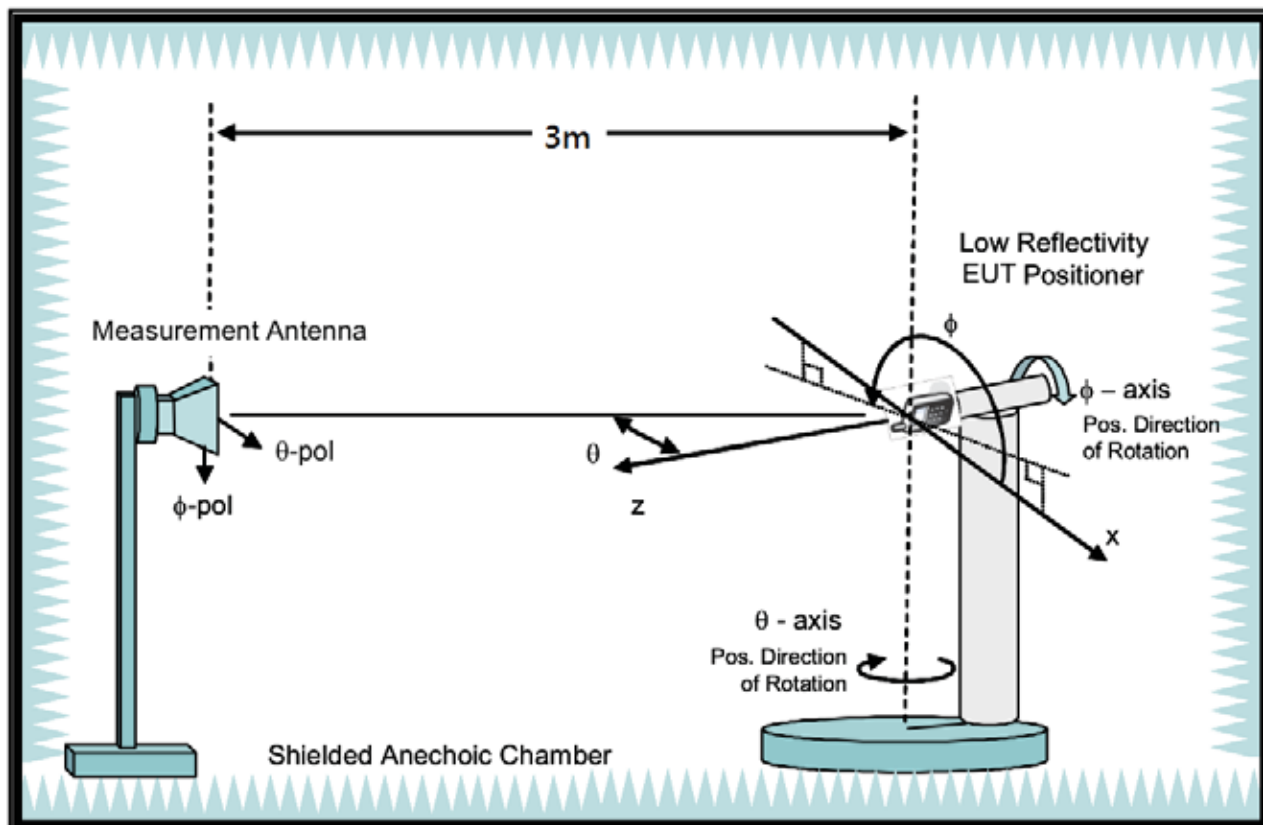
4. Test Facility and Configuration

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.

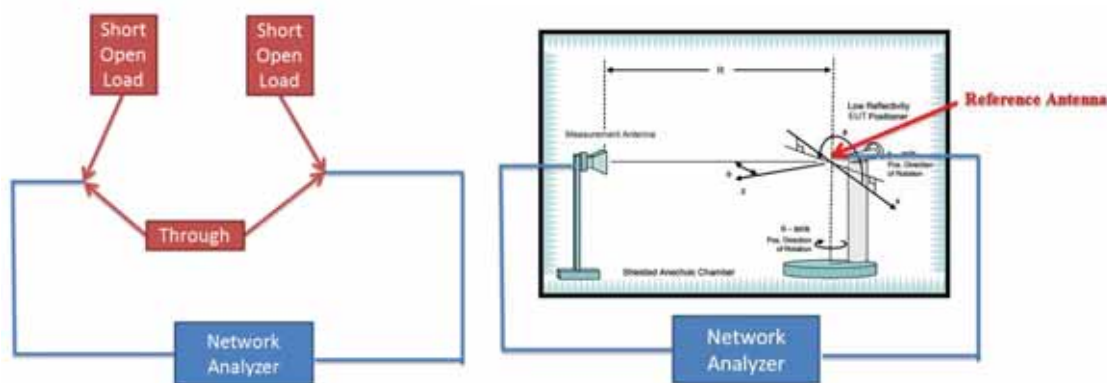
#Reference to CTIA “ctia-test-plan-for-wireless-device-over-the-air-performance-ver-3-7-1”



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:

$$G \text{ reading (dB)} = 20 \cdot \log(V_2/V_1) = 10 \cdot \log(P_2/P_1)$$

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 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.

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)	2.4G	2.45G	2.4835G
Ant. 1 (dBi)	2.88	3.08	2.96
Ant. 2 (dBi)	-16.42	-16.51	-16.93
Ant. 3 (dBi)	2.67	2.44	2.46
DG [1SS] (dBi)	4.49	4.47	4.4
Polarization	Phi	Phi	Phi
$\Theta(^{\circ})$	60	60	60
$\Phi(^{\circ})$	260	270	270

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)	2.4G	2.45G	2.4835G
Ant. 1 [$10^{(G/20)}$]	$10^{(2.88/20)}$	$10^{(3.08/20)}$	$10^{(2.96/20)}$
Ant. 2 [$10^{(G/20)}$]	$10^{(-16.42/20)}$	$10^{(-16.51/20)}$	$10^{(-16.93/20)}$
Ant. 3 [$10^{(G/20)}$]	$10^{(2.67/20)}$	$10^{(2.44/20)}$	$10^{(2.46/20)}$
Ant. 1 [$10^{(G/20)}$] value	1.393	1.426	1.406
Ant. 2 [$10^{(G/20)}$] value	0.151	0.149	0.142
Ant. 3 [$10^{(G/20)}$] value	1.36	1.324	1.327
Sum All Antenna [Amax]	2.904	2.899	2.876
DG [$10 \cdot \log(A_{max}^2/N_{ant})$]	4.49	4.47	4.4

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

**DG_1SS max value position**

Frequency (Hz)	5.2G	5.3G	5.6G	5.785G
Ant. 1 (dBi)	-4.76	-6.2	-3.68	-6.03
Ant. 2 (dBi)	-1.07	-1.27	2.53	2.28
Ant. 3 (dBi)	-2.73	-2.16	-2.26	-6.02
Ant. 4 (dBi)	-0.96	-1.82	-1.31	-1.75
DG [1SS] (dBi)	3.77	3.36	5.16	3.85
Polarization	Theta	Theta	Theta	Theta
$\Theta(^{\circ})$	50	50	60	60
$\Phi(^{\circ})$	160	160	350	350

DG_1SS max value position calculation

Frequency (Hz)	5.2G	5.3G	5.6G	5.785G
Ant. 1 [$10^{(G/20)}$]	$10^{(-4.76/20)}$	$10^{(-6.2/20)}$	$10^{(-3.68/20)}$	$10^{(-6.03/20)}$
Ant. 2 [$10^{(G/20)}$]	$10^{(-1.07/20)}$	$10^{(-1.27/20)}$	$10^{(2.53/20)}$	$10^{(2.28/20)}$
Ant. 3 [$10^{(G/20)}$]	$10^{(-2.73/20)}$	$10^{(-2.16/20)}$	$10^{(-2.26/20)}$	$10^{(-6.02/20)}$
Ant. 4 [$10^{(G/20)}$]	$10^{(-0.96/20)}$	$10^{(-1.82/20)}$	$10^{(-1.31/20)}$	$10^{(-1.75/20)}$
Ant. 1 [$10^{(G/20)}$] value	0.578	0.49	0.655	0.499
Ant. 2 [$10^{(G/20)}$] value	0.884	0.864	1.338	1.3
Ant. 3 [$10^{(G/20)}$] value	0.73	0.78	0.771	0.5
Ant. 4 [$10^{(G/20)}$] value	0.895	0.811	0.86	0.818
Sum All Antenna [Amax]	3.088	2.945	3.624	3.117
DG [$10 \cdot \log(A_{max}^2/N_{ant})$]	3.77	3.36	5.16	3.85

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

**8. Summary of Test Result**

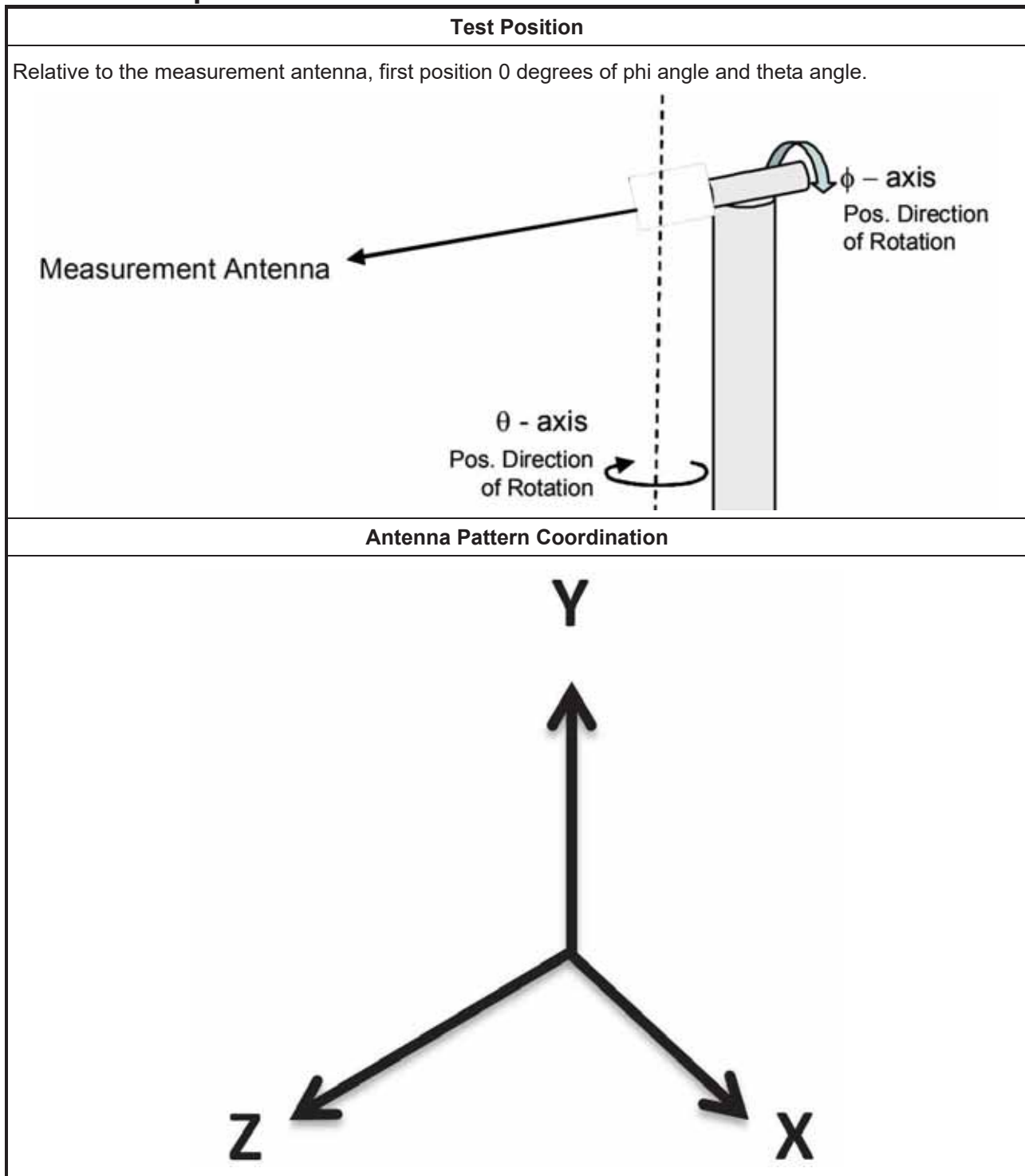
Frequency (Hz)	2.4G	2.45G	2.4835G
Ant. 1 Max Gain (dBi)	2.88	3.61	3.29
Ant. 2 Max Gain (dBi)	4.63	4.58	4.7
Ant. 3 Max Gain (dBi)	2.81	2.44	2.46
Ant. 1 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Phi/60/260	Phi/160/260	Phi/160/260
Ant. 2 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/100/300	Theta/100/300	Theta/110/300
Ant. 3 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Phi/50/270	Phi/60/270	Phi/60/270
Max Gain (dBi)	4.63	4.58	4.7
DG [1SS] (dBi)	4.49	4.47	4.4
DG [3SS] (dBi)	1.04	1.04	0.98

Frequency (Hz)	5.2G	5.3G	5.6G	5.785G
Ant. 1 Max Gain (dBi)	2.52	2.34	2.2	2.37
Ant. 2 Max Gain (dBi)	2.87	2.38	2.89	2.43
Ant. 3 Max Gain (dBi)	2.08	2.58	2.44	2.26
Ant. 4 Max Gain (dBi)	2.14	2.75	2.13	2.1
Ant. 1 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Phi/10/260	Theta/0/180	Phi/20/100	Phi/20/100
Ant. 2 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/70/190	Theta/80/180	Theta/70/350	Theta/60/340
Ant. 3 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Phi/140/90	Phi/140/90	Theta/20/0	Theta/150/160
Ant. 4 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Phi/90/230	Phi/100/230	Theta/130/260	Theta/130/290
Max Gain (dBi)	2.87	2.75	2.89	2.43
DG [1SS] (dBi)	3.77	3.36	5.16	3.85
DG [2SS] (dBi)	2.87	2.75	2.89	2.43
DG [4SS] (dBi)	-1.94	-1.71	-0.51	-1.46

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.

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————THE END————



Radiated Composite Gain

Appendix A

Freq(Hz)	2.4G	2.45G	2.4835G
Ant. 1 Max Gain (dBi)	2.88	3.61	3.29
Ant. 2 Max Gain (dBi)	4.63	4.58	4.7
Ant. 3 Max Gain (dBi)	2.81	2.44	2.46
Ant. 1 Polarization(Θ(")/Φ(")	Phi/60/260	Phi/160/260	Phi/160/260
Ant. 2 Polarization(Θ(")/Φ(")	Theta/100/300	Theta/100/300	Theta/110/300
Ant. 3 Polarization(Θ(")/Φ(")	Phi/50/270	Phi/60/270	Phi/60/270
Max Gain (dBi)	4.63	4.58	4.7
DG [1SS] (dBi)	4.49	4.47	4.4
DG [3SS] (dBi)	1.04	1.04	0.98

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Radiated Composite Gain

Appendix B

Freq(Hz)	5.2G	5.3G	5.6G	5.785G
Ant. 1 Max Gain (dBi)	2.52	2.34	2.2	2.37
Ant. 2 Max Gain (dBi)	2.87	2.38	2.89	2.43
Ant. 3 Max Gain (dBi)	2.08	2.58	2.44	2.26
Ant. 4 Max Gain (dBi)	2.14	2.75	2.13	2.1
Ant. 1 Polarization $\Theta(^{\circ})/\Phi(^{\circ})$	Phi/10/260	Theta/0/180	Phi/20/100	Phi/20/100
Ant. 2 Polarization $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/70/190	Theta/80/180	Theta/70/350	Theta/60/340
Ant. 3 Polarization $\Theta(^{\circ})/\Phi(^{\circ})$	Phi/140/90	Phi/140/90	Theta/20/0	Theta/150/160
Ant. 4 Polarization $\Theta(^{\circ})/\Phi(^{\circ})$	Phi/90/230	Phi/100/230	Theta/130/260	Theta/130/290
Max Gain (dBi)	2.87	2.75	2.89	2.43
DG [1SS] (dBi)	3.77	3.36	5.16	3.85
DG [2SS] (dBi)	2.87	2.75	2.89	2.43
DG [4SS] (dBi)	-1.94	-1.71	-0.51	-1.46

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Antenna Pattern

Appendix C.1

φ(θ°)	1.511-1.70	-2.34-4.78	7.95-5.88	-3.87-3.72	-4.01-3.70	-3.90-4.13	-3.83-5.19	-5.53-4.18	-3.13-2.27	-1.47-1.15	-1.01-0.82	0.75-0.58	-0.35-0.48	-0.62-0.32	0.05-0.38	0.42-0.01	-6.61-1.15	-1.59-1.43
φ(70°)	1.29-1.15	-2.02-0.52	8.35-5.45	-4.01-4.63	-3.55-5.23	-4.43-3.95	-3.58-4.14	-5.09-4.01	-2.34-0.82	0.33-0.21	-0.08-0.05	0.77-1.59	1.62-1.74	2.08-2.05	1.99-0.20	1.86-1.89	1.70-1.02	0.24-0.48
φ(80°)	0.15-0.11	-0.53-0.18	-4.81-3.18	-2.34-3.98	-5.39-5.41	-4.82-0.25	-3.42-4.83	-4.72-7.01	-3.45-0.33	0.84-0.84	0.44-0.87	1.89-2.85	3.04-2.22	3.31-2.81	2.54-0.34	3.42-0.25	2.59-1.57	0.55-0.10
φ(90°)	0.04-0.34	-2.73-8.84	-6.72-3.32	-3.18-4.91	-5.44-4.62	-5.21-4.78	-3.86-4.31	-5.57-7.02	-4.96-1.68	-0.43-0.25	0.31-0.75	1.99-3.38	3.56-3.74	3.82-2.94	1.95-2.72	3.55-3.37	3.31-3.53	1.14-0.12
φ(100°)	2.89-1.59	-4.65-13.17	-6.86-3.61	-4.16-8.03	-10.05-7.44	-6.53-4.90	-4.28-4.33	-4.83-6.79	-6.00-2.01	-0.38-0.03	-0.24-0.24	2.09-3.72	3.50-4.02	3.87-2.16	1.86-3.60	4.72-4.39	2.77-2.20	-1.06-3.83
φ(120°)	4.99-4.00	-6.55-10.10	-6.82-6.48	-6.87-10.40	-14.01-11.53	-8.44-6.24	-6.15-5.40	-5.86-9.02	-3.77-1.00	0.62-0.45	-1.50-0.48	2.25-2.97	2.74-3.57	3.39-2.16	2.19-3.69	4.75-3.79	1.43-0.56	-2.58-5.11
φ(140°)	4.32-3.35	-4.09-6.13	-6.82-12.50	-7.72-7.54	-12.76-13.80	-12.89-8.17	-9.11-9.14	-8.25-10.28	-3.69-0.16	-0.36-0.91	-4.44-1.74	0.56-0.91	1.45-2.51	2.09-2.20	-0.30-0.67	1.92-1.55	-0.29-2.61	-4.46-7.47
φ(160°)	5.52-5.18	-7.02-12.05	-6.77-8.47	-10.21-14.34	-14.03-14.08	-13.14-11.35	-12.87-11.76	-10.39-10.81	-4.89-2.82	-3.81-5.28	-5.11-1.10	-3.88-3.15	-1.89-1.88	-3.29-4.55	-3.64-2.12	-0.44-0.03	-0.41-0.35	-6.57-8.93
φ(180°)	-10.11-9.92	-12.02-12.76	-9.86-9.34	-11.74-13.93	-13.83-13.39	-13.02-13.34	-11.58-10.00	-9.90-9.33	-7.36-6.17	-7.01-7.76	-8.11-8.44	-4.38-4.67	-5.65-6.14	-6.63-6.48	-5.81-6.47	-6.28-6.66	-8.92-8.85	
φ(190°)	-12.16-11.33	-10.46-10.29	-9.43-9.99	-10.53-12.28	-11.41-11.78	-11.53-9.85	-9.69-9.55	-8.21-9.84	-7.59-7.29	-7.88-8.70	-8.80-10.30	-10.76-10.38	-11.49-11.91	-13.69-13.75	-13.54-12.88	-12.90-10.04	-8.27-10.58	-8.22-9.90
φ(200°)	-12.77-11.55	-10.70-9.79	-9.26-9.54	-10.11-11.85	-9.45-9.77	-9.59-9.79	-9.51-9.64	-8.70-9.14	-8.89-8.69	-8.70-9.14	-8.89-8.69	-8.70-9.14	-8.70-9.14	-8.70-9.14	-8.70-9.14	-8.70-9.14	-8.70-9.14	-8.70-9.14
φ(210°)	-15.41-10.82	-10.56-11.14	-10.89-11.87	-12.45-12.14	-12.77-12.28	-12.77-11.90	-12.13-11.48	-10.75-10.45	-10.39-10.45	-10.39-10.45	-10.39-10.45	-10.39-10.45	-10.39-10.45	-10.39-10.45	-10.39-10.45	-10.39-10.45	-10.39-10.45	-10.39-10.45
φ(230°)	-19.90-12.38	-13.82-13.81	-13.36-12.87	-13.12-13.41	-13.86-13.86	-13.19-14.00	-13.26-12.59	-12.45-12.77	-13.45-13.83	-12.72-13.18	-13.61-12.88	-13.82-14.10	-13.29-12.91	-13.18-13.42	-12.84-13.69	-13.06-12.94	-14.03-13.11	-13.44-13.87
Freq(Hz)	2.42GHz	Total(dB)	3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3
Gain	φ(70°/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°))
φ(70°)	0.17-0.06	-0.06-0.01	0.11-0.19	0.23-0.16	0.17-0.28	0.37-0.82	0.73-0.80	0.57-0.18	-0.30-0.48	-0.55-0.54	0.24-0.11	0.22-0.24	0.12-0.05	-0.08-0.09	-0.27-0.15	0.01-0.18	0.47-0.48	0.41-0.32
φ(10°)	0.64-0.48	0.40-0.37	0.34-0.34	0.21-0.10	0.03-0.05	0.08-0.26	0.31-0.30	0.16-0.14	-0.60-1.00	-0.89-0.90	0.70-0.52	0.50-0.59	-0.72-0.67	-0.58-0.38	-0.44-0.27	0.08-0.40	0.53-0.70	0.53-0.70
φ(20°)	0.47-0.49	0.47-0.29	0.07-0.12	-0.22-0.23	-0.30-0.21	-0.09-0.12	-0.11-0.28	-0.52-0.82	-1.01-1.11	-1.13-0.99	-0.86-0.72	-0.76-0.71	-0.39-0.08	0.55-0.79	0.77-0.47	-0.01-0.15	-0.18-0.17	0.06-0.31
φ(30°)	0.30-0.42	0.27-0.02	-0.27-0.11	0.33-0.76	1.00-1.18	1.21-1.05	0.78-0.28	-0.43-1.03	-1.18-1.10	-1.24-1.41	-1.07-1.00	-0.78-0.39	0.14-0.68	1.07-1.17	1.00-0.71	0.39-0.04	-0.45-0.70	-0.52-0.12
φ(40°)	-1.17-0.76	-0.74-1.02	-0.78-0.02	0.88-1.30	1.44-1.55	1.60-1.59	1.49-1.38	0.20-0.32	-1.18-1.08	-1.18-1.08	-1.34-1.83	0.82-1.32	1.84-1.86	1.42-0.69	-0.34-1.50	-2.30-2.01	-2.30-2.01	-2.30-2.01
φ(50°)	-4.53-3.72	-2.90-4.23	-1.40-0.23	0.33-0.50	0.71-0.82	0.87-0.68	0.63-0.47	0.03-0.47	-1.11-1.21	-3.72-4.33	-3.02-1.29	0.08-1.08	1.71-2.19	2.87-2.87	2.79-2.31	1.38-0.19	-1.06-0.14	-2.32-3.48
φ(60°)	-5.99-6.69	-6.50-6.79	-4.88-2.51	-1.82-1.13	-0.24-0.50	0.78-0.86	0.60-0.78	0.33-0.89	-2.39-3.45	-6.53-6.51	-3.91-1.51	0.10-1.13	2.00-2.52	2.75-2.60	2.29-2.08	1.80-0.46	-1.22-0.82	-3.88-4.80
φ(70°)	-8.88-10.35	-9.62-8.76	-7.37-5.67	-4.06-2.40	-1.17-0.22	0.50-0.77	0.89-0.92	0.96-2.33	-5.70-10.21	-11.70-7.61	-3.93-1.34	0.72-2.10	2.67-2.65	1.90-1.12	0.98-0.39	0.15-0.54	-1.90-0.41	-5.96-7.55
φ(80°)	-5.39-6.01	-6.07-5.95	-5.65-4.76	-3.36-0.92	0.48-0.87	1.05-0.68	0.02-0.64	0.57-1.00	-10.81-8.50	-4.54-3.68	-1.34-3.33	1.20-1.65	1.62-1.17	0.51-0.27	-1.25-0.77	-3.75-3.96	-4.21-4.35	
φ(90°)	-8.89-8.30	-6.49-6.43	-5.11-3.76	-2.90-1.35	-0.53-0.41	-0.31-0.52	-1.34-1.83	-2.39-3.83	-4.20-8.19	-6.54-8.91	-4.48-6.09	-3.45-1.72	-0.74-0.89	0.67-0.75	0.74-0.67	-1.76-3.00	-3.85-4.86	
φ(100°)	-6.69-5.74	-4.99-4.75	-4.49-4.18	-3.04-2.08	-1.07-1.17	0.74-0.25	0.32-0.35	-0.47-0.32	-7.54-6.32	-5.99-6.14	-4.29-1.98	-0.67-0.31	0.72-0.19	-0.02-0.85	-2.07-0.95	-3.89-4.76	-3.89-4.76	
φ(120°)	-13.78-9.83	-6.12-3.38	-1.80-1.02	-1.74-0.18	1.94-0.43	1.67-0.08	2.50-4.72	6.83-11.14	-11.41-9.32	-6.76-9.24	0.95-1.03	7.41-6.84	2.53-0.80	0.98-1.65	1.76-0.94	-0.29-0.48	-4.74-6.45	-4.74-6.45
φ(140°)	-7.75-6.49	-5.30-3.92	-1.77-0.02	-0.36-1.03	-0.04-0.46	-0.46-0.55	-0.40-4.57	-5.79-7.81	-6.31-5.96	-7.96-7.07	-6.70-7.91	-5.20-6.95	-4.39-3.35	-1.92-1.16	-1.69-0.49	-5.63-0.27	-12.65-9.51	-4.80-2.55
φ(160°)	-8.46-6.94	-6.04-5.96	-3.68-0.74	0.40-0.02	0.52-0.48	0.22-0.97	0.23-0.45	-2.19-3.37	-3.45-4.57	-6.41-6.69	-6.77-12.51	-12.56-7.98	-4.12-0.37	-1.52-1.22	-1.96-0.34	-4.07-0.15	-8.56-13.20	-13.30-10.71
φ(180°)	-4.48-3.34	-2.30-0.21	-3.31-2.98	-1.98-0.04	0.31-0.07	-0.27-0.95	-2.41-4.44	6.41-6.69	-6.16-5.76	-5.08-0.05	-3.78-0.14	-4.34-0.92	-3.44-3.39	-4.02-5.60	-6.90-7.85	-8.35-9.62	-10.40-8.90	-7.62-6.78
φ(190°)	-5.67-3.66	-1.58-0.46	0.36-0.15	0.30-0.87	1.40-1.38	0.30-0.46	0.71-0.17	0.71-0.17	-0.30-0.28	-0.31-0.61	-3.48-5.70	-6.34-1.57	-12.67-13.52	-13.16-12.79	-12.85-12.59	-12.78-11.45	-9.50-7.43	
φ(200°)	-12.58-12.17	-8.89-6.69	-3.53-2.22	-1.42-0.94	0.08-0.60	0.74-0.85	0.86-0.69	0.25-0.44	-1.47-2.39	-3.16-3.75	-4.79-6.96	-6.89-12.28	-12.84-10.30	-8.67-7.31	-6.99-7.47	-0.89-0.00	-10.01-10.52	-11.01-11.88
φ(210°)	-4.76-5.84	-7.29-6.33	-8.53-7.59	-7.05-6.57	-6.06-5.37	-5.27-6.60	-6.17-7.18	-7.10-6.44	-6.25-6.08	-6.76-7.37	-4.70-4.15	-3.59-2.63	-2.81-2.30	-2.16-2.19	-2.39-2.66	-2.39-2.66	-3.22-3.80	
φ(230°)	-4.26-4.66	-4.83-6.09	-5.19-5.15	-5.71-5.91	-4.14-6.18	-4.46-5.92	-5.06-4.21	-3.32-2.34	-1.75-1.27	-1.17-1.30	-1.58-1.90	-2.15-0.42	-2.74-3.03	-3.06-3.32	-3.54-3.50	-3.43-3.57	-3.57-3.79	-3.82-4.03
Freq(Hz)	2.45GHz	Total(dB)	3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3
Gain	φ(70°/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°))
φ(70°)	0.41-0.51	0.69-0.75	0.78-0.67	0.45-0.30	0.21-0.26	0.16-0.17	0.23-0.33	0.40-0.55	0.50-0.42	-0.09-1.07	0.12-0.06	-0.04-0.01	-0.07-0.03	-0.09-0.07	-0.07-0.03	0.21-0.25	0.08-0.02	0.06-0.08
φ(10°)	0.42-0.43	0.42-0.39	0.31-0.18	0.03-0.11	-0.19-0.21	-0.31-0.44	0.51-0.45	-0.27-0.05	0.11-0.09	0.07-0.38	-0.57-0.69	-0.72-0.63	-0.59-0.61	-0.63-0.74	-0.78-0.61	-0.34-0.21	-0.06-0.00	0.05-0.17
φ(20°)	0.17-0.03	-0.26-0.69	-0.91-0.86	-0.68-0.62	-0.46-0.31	-0.37-0.58	-0.68-0.73	0.68-1.19	-1.43-1.52	-1.35-1.00	-1.35-1.00	-0.79-0.47	-0.37-0.24	-0.32-0.46	-0.61-0.76	-0.76-0.45	-0.20-0.09	-0.20-0.09
φ(30°)	0.09-0.32	-0.76-1.30	-1.37-0.82	0.07-0.58	0.94-1.17	1.13-0.82	0.28-0.35	-0.94-1.21	-1.15-1.28	-1.68-1.16	-2.36-1.25	-1.63-1.01	-0.47-0.80	0.36-0.53	0.36-0.68	-0.13-0.24	-0.23-0.17	0.02-0.04
φ(40°)	-0.81-0.78	-0.91-1.24	-0.73-0.17	0.32-0.34	1.91-1.85	1.94-1.85	0.80-0.89	-0.88-1.04	-2.76-2.65	-2.76-2.65	-2.76-2.65	-2.76-2.65	-2.76-2.65	-2.76-2.65	-2.76-2.65	-2.76-2.65	-2.76-2.65	-2.76-2.65
φ(50°)	-3.82-3.39	-2.51-1.33	-0.80-0.29	0.03-0.87	1.36-1.87	0.94-0.63	-0.01-1.00	-1.46-1.96	-3.18-4.40	-4.93-2.65	-1.36-1.11	0.60-1.34	1.98-2.27	2.27-1.70	0.73-0.35	-1.15-1.88	-2.91-3.67	-2.91-3.67
φ(60°)	-5.12-5.65	-4.95-6.31	-1.94-0.47	0.55-0.59	1.28-1.70	1.59-1.55	0.33-0.14	-0.75-0.91	-3.15-0.55	-5.32-0.59	-4.94-3.60	-1.28-0.20	0.77-1.67	2.14-2.83	2.17-1.63	0.75-0.49	-1.87-1.70	-3.16-3.97
φ(70°)	-5.12-5.27	-7.85-6.34	-4.85-3.29	-1.91-0.56	0.94-1.21	0.68-1.33	1.21-0.85	0.28-1.35	-7.72-7.47	-5.33-3.18	-1.06-0.59	1.56-1.99	1.85-1.23	0.73-0.41	-0.22-1.39	-3.13-3.38	-7.13-6.23	
φ(80°)	-6.75-6.64	-5.99-6.56	-4.87-4.58	-2.92-0.82	0.40-0.91	1.30-1.34	0.83-0.15	-0.52-2.51	-4.77-10.51	-13.69-10.52	-6.77-3.94	-1.49-0.11	1.07-1.67	1.82-1.48	0.74-0.49	-1.30-3.23	-4.36-5.14	-5.77-6.34
φ(90°)	-4.36-4.64	-4.90-4.58	-3.56-3.81	-2.77-0.83	-0.29-0.03	-0.45-0.43	0.37-1.19	-1.42-2.46	-4.82-7.59	-6.43-0.37	-2.07-0.89	-0.80-0.93	1.50-1.49	1.01-0.48	-0.36-0.31	-4.69-6.78	-5.96-6.58	
φ(100°)	-4.36-4.69	-4.52																

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





Appendix C.2

[illegible]



Antenna Pattern

Appendix C.2

Theta(°)	0.58074	0.471016	0.767229	-4.25577	7.086382	-4.389284	0.341151	-1.009088	-0.177052	0.82010	1.171128	-2.381322	-3.831388	-3.486279	-3.993378	-2.151059	0.995054	0.58072
Phi(°)	1.07126	0.859103	1.520357	-5.295477	6.554438	-2.691134	0.430114	0.28011	0.23017	1.35125	0.160102	0.332192	4.431535	-5.281433	-5.604491	4.511204	0.68817	1.33111
Theta(°)	-0.51157	-1.314188	-1.591283	-0.740645	6.61618	-4.250113	-1.702686	0.360107	-0.081493	2.49139	-0.150104	-0.201074	-0.581168	-2.181427	-0.891162	-2.93142	-0.53010	
Phi(°)	0.601133	-1.313427	3.351437	-6.461899	6.191416	-1.711072	0.541125	0.471014	0.631041	-1.150108	1.631138	-1.970110	4.511181	-1.591086	-0.64140	-1.571434	-0.671428	-1.971041
Theta(°)	-1.111023	-3.151441	5.321576	-6.991888	4.161412	-2.671066	4.141317	2.48125	2.381357	-3.571153	3.371284	3.811142	-1.241035	0.40248	-0.561259	-4.651462	-6.321777	-4.381109
Phi(°)	0.981631	6.191844	-10.781214	-13.661135	4.401572	-3.651139	-3.741339	2.691273	2.941481	4.051492	2.321125	-2.391284	-1.861143	4.771512	4.501720	-10.361628	-2.991477	-8.571331
Theta(°)	-4.191524	-6.611689	-7.571130	-13.521834	4.051522	-6.271636	-7.731721	5.911483	-6.041563	-5.071361	3.821045	2.681455	-3.161256	6.091711	-7.451241	-3.651655	-7.121344	
Phi(°)	4.261101	-13.001185	-10.571329	-13.671189	6.191653	-7.141628	-9.601104	9.501858	-6.061615	-7.21107	8.491483	7.981656	-2.911329	5.951622	-3.351477	6.881675	-4.381644	-1.241631
Theta(°)	-12.221073	-11.571238	-10.581285	-11.111034	-10.271107	-6.581102	6.281841	-7.50188	6.441114	-6.77157	8.781756	5.681913	6.221778	4.82178	-1.151181	-1.88110	-1.68110	
Phi(°)	7.091687	-7.121838	6.241894	-9.991913	6.571105	-11.451232	6.591791	6.141691	-7.511710	-7.00172	7.391488	3.221515	6.311236	-13.171327	-11.591111	8.211422	-8.001207	-12.371898
Theta(°)	4.491854	6.371731	-10.501234	-13.021171	-13.611170	-13.361143	-13.841179	-11.201630	4.911580	4.571255	2.711584	5.991891	6.411918	6.231846	-11.711148	-10.441758	-7.791377	8.481813
Phi(°)	4.871137	-13.571145	-13.601154	-13.711283	-13.371283	-13.761178	-12.191158	-12.191158	-13.591129	-10.301121	-13.601132	-13.601132	-13.601132	-13.601132	-13.601132	-13.601132	-13.601132	-13.601132
Theta(°)	-13.601137	-12.391189	-13.521124	-12.451137	-11.581202	-13.091219	-13.551128	-12.331130	-10.431908	-8.981058	8.721844	-11.571092	-10.781115	-11.841148	-10.471085	-10.591098	-10.481084	-11.261128
Phi(°)	5.62184	Total(°) 2	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-
Gain	Phi(°)Psi(°)	Phi(°)Psi(°)	Phi(°)Psi(°)	Phi(°)Psi(°)	Phi(°)Psi(°)	Phi(°)Psi(°)	Phi(°)Psi(°)	Phi(°)Psi(°)	Phi(°)Psi(°)	Phi(°)Psi(°)	Phi(°)Psi(°)	Phi(°)Psi(°)	Phi(°)Psi(°)	Phi(°)Psi(°)	Phi(°)Psi(°)	Phi(°)Psi(°)	Phi(°)Psi(°)	Phi(°)Psi(°)
Theta(°)	-7.581724	-7.051763	8.301845	-8.241765	7.971796	8.391845	8.751938	6.181921	-0.261936	8.031815	8.691888	8.621814	-7.201738	-7.771779	-7.101766	8.231830	7.431784	8.121833
Phi(°)	6.431888	-7.651713	8.021880	-9.051933	-10.171978	8.241791	7.731700	4.291826	-6.181765	4.561728	7.011747	8.101859	8.311818	-7.911756	-7.541899	-7.281774	-7.331732	-6.671788
Theta(°)	-5.001561	-6.361786	6.961861	-10.891129	-11.921139	-10.691791	6.681532	-1.401348	-3.511383	-3.661385	4.621581	-4.891454	-4.221414	-3.891455	-4.261442	-4.681426	-4.671401	-4.571708
Phi(°)	2.241325	-4.851746	7.891771	-7.911862	6.321925	-6.261842	6.521614	-4.581353	-3.431288	-3.251247	2.101284	-0.021421	-1.511645	-4.881414	-3.39135	-2.271176	-1.141611	-0.581151
Theta(°)	0.071117	-1.661222	3.391375	-5.651853	-11.691152	9.211759	3.941725	-3.321303	-2.581151	-1.231052	8.831149	2.891405	-4.761457	-5.891423	-3.121591	0.90131	0.591166	0.710137
Phi(°)	1.748193	0.09105	0.621175	-3.411578	-7.521788	6.491474	3.171122	-5.98117	-0.701102	0.040106	0.801708	2.361241	-3.331475	-5.901404	-3.111109	0.271088	0.42126	2.141224
Theta(°)	2.41135	0.871614	0.931221	-3.191460	-4.521483	-5.671379	-1.461707	-1.151119	0.44188	0.110135	1.04150	0.110135	-3.991435	-2.451174	0.67186	1.12124	2.51127	
Phi(°)	2.14128	2.32186	0.071169	-4.101679	6.211440	-3.101310	2.621220	0.31186	-0.051799	0.14128	0.40102	-0.081057	-3.501514	-5.671567	-5.891599	0.99127	0.83101	2.06117
Theta(°)	1.05167	1.38103	-1.131135	2.751234	-1.941134	-1.741122	0.50126	-1.361231	-1.171134	0.151627	-1.171134	-1.581627	-4.591530	-1.621512	-4.591530	-1.931491	-1.011508	1.20121
Phi(°)	0.48162	-0.161135	2.411485	-5.101438	-1.761139	-1.121261	-0.371305	-1.231438	-1.181148	-1.37126	0.931187	0.491105	0.531405	-0.35106	-0.401134	3.251438	-3.761237	0.48180
Theta(°)	-1.981411	-2.35121	-1.171384	-4.05173	-5.591386	-3.481214	-0.391103	-2.901149	-2.901149	-2.911159	-2.501191	-2.501191	-1.761172	-0.60199	0.581178	-5.791375	-3.411372	3.09184
Phi(°)	4.26158	3.511519	3.511519	-10.271140	3.981159	3.981159	4.891492	3.981448	6.651799	6.721312	4.301382	4.301382	6.011621	6.011621	4.301382	4.301382	4.101159	7.921196
Theta(°)	-5.96127	-3.911336	7.671181	-12.07198	5.931564	-4.821614	4.561640	6.901437	5.171727	-7.23120	5.351378	4.631515	-4.371495	-3.791721	-5.92185	5.391818	4.961855	6.591430
Phi(°)	8.67148	-11.361152	-7.441885	-13.481205	8.611891	-6.301758	6.561847	-4.761886	-7.921838	6.871858	-7.981768	4.161432	9.181190	3.92109	8.971725	-7.531835	-13.1418	
Theta(°)	-10.261220	-12.221141	-13.261138	-13.321185	-10.641598	8.94184	-12.63137	-7.221486	5.471571	-9.131204	-13.451449	-10.391765	8.521913	9.751107	-10.26193	8.841408	-12.941102	-12.19189
Phi(°)	-11.391638	-8.021222	-6.0611091	-10.211333	-11.641161	-10.211333	-11.641161	-6.061109	-7.671458	-6.981539	5.081633	4.741915	-6.951722	-7.511635	-6.951722	-5.731778	-6.831131	-12.19189
Theta(°)	6.411515	-8.13189	-11.871122	-11.971123	-13.581128	-11.021657	8.741925	-12.89189	-7.981533	4.641472	6.991808	6.0311029	-13.721134	-11.681163	-10.121495	-13.951151	-5.76154	6.021815
Phi(°)	-18.98185	-13.9611376	-10.421125	-11.621283	-12.161162	-11.701127	-10.891147	-7.69180	-6.80130	-8.911934	-13.361134	-13.191132	-13.421163	-11.481153	-10.571352	-11.671472	-4.481792	-7.741667
Theta(°)	-13.4811294	-13.4211347	-13.7611359	-13.611241	-13.7211282	-13.3411388	-13.7411318	-12.9911328	-12.8211324	-13.7311388	-12.3711333	-13.5111386	-13.8611340	-14.0411386	-13.4211319	-13.5411388	-12.7711241	-12.7011388
Phi(°)	5.785184	Total(°) 3	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-
Gain	Phi(°)Psi(°)	Phi(°)Psi(°)	Phi(°)Psi(°)	Phi(°)Psi(°)	Phi(°)Psi(°)	Phi(°)Psi(°)	Phi(°)Psi(°)	Phi(°)Psi(°)	Phi(°)Psi(°)	Phi(°)Psi(°)	Phi(°)Psi(°)	Phi(°)Psi(°)	Phi(°)Psi(°)	Phi(°)Psi(°)	Phi(°)Psi(°)	Phi(°)Psi(°)	Phi(°)Psi(°)	Phi(°)Psi(°)
Theta(°)	-10.821138	-12.8411134	-10.7811103	-10.8411084	-10.8711036	-10.5911074	-10.7911103	-11.6011056	-10.011052	-9.9511067	-10.8211134	-11.211187	-11.9511055	-10.011084	-9.9811127	-11.7411155	-11.6911038	
Phi(°)	0.651825	8.231846	8.401885	-10.501180	-11.8311201	-13.1911273	-12.2211343	9.441872	-7.771833	-3.86167	4.841852	7.731801	-8.031847	-8.091809	-9.581827	-8.251788	-7.521806	-10.95184
Theta(°)	6.471789	-7.441733	7.531826	-8.4011129	-11.7811074	-12.5911583	-11.641896	9.461754	-4.771621	-1.171051	4.941854	6.021594	-6.281646	-6.071610	-4.581476	-4.281461	-4.561476	-5.231533
Phi(°)	3.771512	-5.981483	6.631741	-7.911678	6.791862	-7.891781	6.931822	4.831361	-3.201181	-1.861237	-1.891233	3.301439	-3.421415	-3.771520	-5.531439	-3.281302	-1.911160	2.321341
Theta(°)	-2.031267	-3.211338	-4.201749	-5.861618	6.681707	-7.511586	6.581734	6.361525	6.16122	6.361525	6.16122	6.361525	6.16122	6.361525	6.16122	6.361525	6.16122	6.361525
Phi(°)	1.741188	0.481615	-1.471238	-6.001610	-7.281667	6.421836	5.591429	1.991427	-1.251877	4.46101	6.591895	4.291711	-6.441688	-4.501196	4.86165	1.141807	1.90174	
Theta(°)	1.49155	0.761428	0.381691	-1.211238	3.201456	6.241271	3.211232	1.891826	-1.181013	0.891848	6.69181	6.69181	6.69181	6.69181	6.69181	6.69181	6.69181	6.69181
Phi(°)	1.21137	1.791107	0.821894	2.641385	3.941254	1.361120	1.011409	-1.101171	-1.89196	5.03126	6.141684	3.211344	-3.211344	-3.211344	-3.211344	3.211344	3.211344	3.211344
Theta(°)	1.49154	1.64140	0.361174	2.501196	1.631246	2.441057	0.661640	1.19158	0.281004	0.131017	0.76159	6.15115	2.711398	5.431401	2.761291	2.531558	4.421623	1.351198
Phi(°)	0.48198	0.841106	1.611347	-3.471315	-1.041269	-0.881119	1.981151	-1.091126	-1.991022	4.271120	-1.43180	0.531607	-0.47180	0.531607	-0.47180	0.531607	0.531607	0.531607
Theta(°)	-1.64174	-3.801256	-1.001233	-3.591383	-1.991235	-3.331301	-1.841291	-1.851139	-3.871498	-4.381192	-1.231101	-1.961748	0.151088	0.59103	0.841173	-0.681277	-3.441822	-1.48103
Phi(°)	-4.92162	-4.831496	-4.841720	-8.461620	-3.291156	-3.741479	-4.111268	-4.191348	-4.591572	-4.391442	-4.731434	-4.851395	-3.861276	-1.82133	-13.951733	-4.911767	-4.41177	
Theta(°)	7.951725	-3.571475	6.861193	-13.341386	6.761516	4.951421	5.771699	5.681434	5.711782	6.021768	6.241236	6.081308	-5.801537	-7.031524	-4.49137	6.981784	6.651057	6.851483
Phi(°)	6.861555	-6.611658	-10.421130	-13.5611068	-7.891792	-6.7411207	6.691737	6.911626	6.711135	-10.841162	7.731195	6.4211016	-10.981637	-10.201180	-6.5511674	-11.561797	-7.071117	-6.841485
Theta(°)	9.241867	-8.9711014	-12.101139	-13.3711289	-11.631854	-7.631784	6.301792	5.161326	-4.481572	8.961450	-10.421818	8.811859	-8.221933	-9.661795	-9.871806	-10.761866	-13.201	



Antenna Pattern

Appendix C.2

φ(10°)	4.001534	-4.011378	5.550719	-4.793589	7.020745	-8.161040	9.101485	-7.688783	-8.581098	-9.991779	6.371508	5.641498	-4.121438	-3.851311	-3.571458	4.121687	4.561392	-3.571327
φ(10°)	-12.751146	8.521012	-11.781127	-10.841710	9.701064	-11.851130	-11.701095	-13.021233	-10.241897	4.761391	2.971229	1.941104	-0.881081	-1.181176	-1.541175	-1.851232	-1.801279	5.131855
φ(10°)	-4.111391	-4.861582	6.841823	-6.481919	-7.761775	-6.501822	-6.201873	-7.461724	-6.911744	-8.901498	6.501934	6.501934	-10.771108	-10.391893	-8.281442	-4.891787	-7.111520	
FreeGain	5.7850Psi		TotalAnt. 3															
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°))
φ(0°)	2.221206	2.141188	2.751247	2.501243	2.861313	2.731291	2.301255	2.211401	2.221197	-1.931216	2.891229	2.891222	-2.381297	3.381323	2.811238	2.651250	2.581213	2.111236
φ(10°)	1.911282	-2.751386	4.591441	-4.911582	4.681413	-4.861522	4.381405	-3.951357	-3.591327	-3.081386	4.131419	-4.361483	-4.661511	-4.521388	-3.931380	-3.451387	-3.831187	-1.991207
φ(20°)	3.071418	-3.281378	4.081496	-3.761448	4.321448	-4.081555	4.321497	-4.291523	-3.711537	4.151498	-4.251507	3.591522	-3.571521	-2.991549	-2.201515	-2.151524	-2.131524	3.981352
φ(30°)	2.511525	3.321458	5.021589	-4.251731	5.891174	-7.271419	4.451511	-4.761515	4.101527	-3.501545	4.101532	-3.581532	-2.931532	-2.591535	-2.291535	-2.591535	-2.591535	3.921352
φ(40°)	4.491328	3.191434	6.551748	-6.231452	4.511471	-5.281755	6.971939	-6.461591	4.011427	-3.881491	6.431515	-6.431515	-6.191518	-4.191514	-5.091348	-3.741348	-4.651353	2.891327
φ(50°)	2.941383	4.051578	5.721479	-5.171523	5.461551	-4.381559	4.251485	-4.181511	4.531527	-3.751565	6.261798	-6.481636	-4.641436	-3.791218	-3.231218	-2.311519	-2.331411	5.541575
φ(60°)	4.631428	5.781487	5.391348	-2.801229	3.101423	-2.441346	5.181513	-4.691418	7.701787	-8.991792	6.741894	-8.901807	-7.271558	-3.621239	-2.871403	-2.921478	-2.321478	7.231427
φ(70°)	8.051757	-7.771765	6.781522	-5.781421	5.381450	-4.151517	4.661304	-4.891575	-7.531832	-13.481283	-11.031212	-10.901800	-7.821487	-5.501434	-4.501611	-6.581440	-4.281779	7.861533
φ(80°)	-12.251482	-8.801771	-8.811441	-7.901791	4.621480	-4.781527	-4.801682	-4.671728	-10.721802	-11.201330	-12.771840	-6.201588	-5.581444	-7.281734	-7.021888	-11.031802	-6.381948	
φ(90°)	-13.001818	-8.361545	-6.621209	-11.341678	3.931147	-3.951785	-3.591275	-5.051662	-10.901800	-11.221335	-9.441442	-4.501323	-2.751185	-3.191839	-3.771814	-13.331081	-7.571108	
φ(100°)	7.621733	-5.311632	-8.881513	-8.881606	5.201317	-5.871813	-6.021368	-6.851981	-8.661412	-12.861344	-13.521308	-11.091239	-7.581414	-4.461233	-2.431286	-6.131113	-6.671830	-8.551873
φ(110°)	-4.881503	-4.871935	8.671819	-7.571777	7.651658	-6.691844	-13.321155	-11.101333	-13.321147	-13.451332	-10.831370	-10.481488	-12.201851	-4.691193	-5.141530	4.351870	6.541780	-8.751528
φ(120°)	-10.221144	-6.351601	-8.461773	-8.261931	-6.411120	-6.081554	-5.031601	-6.181734	-8.651038	-12.471887	-13.941122	-11.761102	-7.631641	-5.521608	-11.481544	-7.481102	-11.721708	-7.331330
φ(130°)	-2.121357	-3.691461	-3.631336	-6.071800	-11.531196	-12.331316	-6.971480	-8.891742	-6.811867	-7.371337	-7.941143	-6.371774	-4.181104	-4.691536	-6.511588	-4.931487	-12.451584	-5.121473
φ(140°)	-8.771155	-13.141307	-10.251268	-13.091741	-7.491434	-6.461452	-5.121779	-8.901177	-10.451123	-13.571455	-14.931426	-7.071785	-11.741335	-7.171681	-11.741335	-7.171681	-7.171681	-5.681780
φ(150°)	6.391399	-2.541382	-2.781134	-6.471681	6.271588	-3.701326	-3.531276	-1.011953	-2.781343	-7.011478	-9.781809	-4.631710	-8.781681	-4.631710	-10.741955	-5.411570	-6.001471	-5.091581
φ(160°)	5.081469	-4.681427	-5.761838	-8.371628	6.391754	-7.921633	-8.341900	-11.301227	-10.561127	-10.251989	-8.741701	-7.551742	-8.501744	-7.401522	-4.921137	-7.031754	-6.901517	-6.581581
φ(170°)	8.531399	-8.931152	-10.931139	-13.191158	-13.751149	-13.741132	-13.281284	-12.821130	-13.621119	-8.811510	-3.271230	-2.341205	-2.181225	-2.511137	-3.061230	-3.451738	-3.251231	-3.811585
φ(180°)	5.441548	-4.961640	-7.751730	-7.601786	-7.651779	-8.611585	-6.681588	-7.901756	-6.871547	-7.821764	-8.561879	-8.281814						-8.191712
FreeGain	5.35Psi		TotalAnt. 4															
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°))
φ(0°)	6.701610	6.201620	4.781421	4.141538	4.251477	4.681528	4.361524	4.431438	4.401478	5.921537	6.321547	4.561420	4.221435	4.041743	4.441445	4.731537	4.151800	6.511592
φ(10°)	5.091628	4.301345	3.491366	4.091434	4.611423	4.201458	4.641448	3.811412	3.891389	4.711510	5.501572	6.011537	6.981607	7.401677	8.241675	9.181618	7.001623	10.511672
φ(20°)	3.791337	-3.301292	-2.221269	-3.391336	2.821137	2.731218	3.101216	-1.291141	-1.251145	-1.081142	2.251327	4.281452	5.301458	4.991478	-7.951878	-7.201513	4.201472	5.001434
φ(30°)	2.651283	-3.701340	3.781410	3.691459	4.131427	-2.721239	-1.931449	-4.531808	2.601300	0.281009	1.111285	-4.361538	5.781707	-7.451764	-6.881432	-2.691199	-2.881033	-2.941264
φ(40°)	2.111260	-2.971279	2.121303	-4.331432	4.551577	4.401423	3.241193	-6.771082	-6.151013	-8.021026	-1.141174	2.041365	6.621424	-6.621415	2.981511	-1.861264	-2.191161	
φ(50°)	0.671232	-2.951178	2.431400	-5.011691	6.901613	-4.691331	2.051174	0.331010	0.240410	-0.861126	0.981041	-1.961339	4.761553	-7.021617	-4.181397	4.361449	-1.441132	-1.321433
φ(60°)	-1.151508	-1.391273	-4.721611	6.321796	-6.301798	-4.851066	-0.171055	-0.471055	0.601222	-0.711186	0.071862	-2.821462	-7.581697	6.071852	-6.101522	6.911544	-1.381072	6.651004
φ(70°)	-1.791157	-0.781251	5.331373	-4.341739	7.231697	-4.931462	3.841294	2.091153	0.041805	1.451103	0.871167	-3.511527	-8.231846	-7.331541	-5.471178	5.461375	-3.001139	1.111555
φ(80°)	-3.971154	-2.911399	-4.241526	-8.511831	4.821885	-6.591435	3.311410	-4.401158	-6.451022	-0.881181	0.011616	0.831515	-2.771374	-6.891624	-5.381462	3.891457	-2.881506	0.351230
φ(90°)	-4.361525	-4.701483	-7.881648	-8.411876	8.781640	-5.191416	3.231306	3.881733	-1.641173	0.591148	0.041805	2.811538	2.951511	0.271076	2.441191	2.531592	-1.451149	-1.681127
φ(100°)	-4.401177	-7.311711	-7.081733	-8.651658	-10.361109	-9.981670	-5.501441	-2.711468	-1.941281	-0.571595	1.661275	2.011927	-1.521632	-3.241133	3.021106	-1.381263	-3.231292	-5.091581
φ(110°)	-6.891784	-5.311810	-5.601107	-12.941847	-8.621154	-13.751109	-8.621152	-4.841646	-2.781234	-1.401008	2.931348	0.901719	1.181194	0.991807	-3.871142	3.301576	-4.911554	-1.581111
φ(120°)	-4.651814	-6.651128	-10.391101	-13.801157	-8.851388	-12.831182	-12.701187	-7.271657	-4.561325	0.691195	1.931430	-1.221214	6.391380	-4.831461	-3.801342	-2.331387	-6.821421	-1.801324
φ(130°)	-7.981788	-9.721228	-7.851814	-13.581154	-10.001151	-11.881124	-11.191807	-10.281112	-6.911505	0.621657	2.121931	-1.271931	2.191489	-0.711184	6.721128	2.331272	-10.011798	-4.451291
φ(140°)	-7.791438	-7.221638	-10.181124	-13.501189	-10.701107	-13.181102	-12.381117	-10.701142	-7.691634	0.541834	2.341128	-1.361128	4.931456	-0.901648	6.881118	1.911532	-8.861187	-6.901491
φ(150°)	-8.311851	-13.121110	-10.741117	-13.291158	-13.171159	-13.111161	-12.151161	-12.151161	-8.211608	0.421103	2.441518	-0.801103	6.811618	-0.711184	6.811618	1.911532	-8.861187	-6.901491
φ(160°)	-6.041892	-12.091141	-12.771151	-9.271789	-8.441744	-9.811910	-7.561138	-11.381118	-9.601735	-5.521515	0.671780	-7.871285	-10.131117	-10.081516	-10.171158	-10.471194	-7.281586	
φ(170°)	-12.191180	-12.531122	-10.201107	-10.201103	-9.841103	-10.101223	-12.171178	-13.701171	-10.101223	-8.501797	0.641612	0.801716	0.731462	-7.021811	-8.501116	-13.321167	-11.181105	
φ(180°)	-12.671014	-10.871585	-8.821104	-11.041125	-13.581139	-13.381138	-12.131124	-11.521188	-12.831137	-13.081182	-13.231187	-12.751180	-10.541885	-9.601943	-9.841883	-9.781108	-11.261128	-12.471132
FreeGain	5.35Psi		TotalAnt. 4															
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°))
φ(0°)	4.671497	5.991629	4.781541	6.691645	5.561515	5.221572	6.561586	4.001688	6.591582	4.191490	6.651591	5.351425	6.451637	6.301602	5.991584	5.151555	3.731605	5.221523
φ(10°)	6.691859	6.561587	4.711491	4.951455	5.361441	3.771433	4.401407	3.761442	-0.071488	-4.291513	5.061535	6.251177	7.441934	-10.071674	-7.391751	9.261652	-5.501537	6.141601
φ(20°)	5.441521	5.961645	4.551325	3.091249	2.011710	-1.281180	-1.791185	-1.281183	2.021200	2.851338	3.321138	3.421448	5.951822	9.371688	6.471633	6.371827	3.481407	4

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

