



# Antenna Composite Gain Test Report

Equipment	Wi-Fi 6 Access Point
Brand Name	Cisco
Model Name	MR28-HW, GR12-HW
Applicant	Cisco Systems, Inc. 170 West Tasman Drive, San Jose, CA 95134 USA
Manufacturer	Cisco Systems, Inc. 170 West Tasman Drive, San Jose, CA 95134 USA
Sample Received	Mar. 22, 2022
Start Test Date	Mar. 23, 2022
Final Test Date	Mar. 23, 2022



## Table of Contents

History of this test report.....	3
1. Operation Mode and Antenna Information .....	4
2. Test Frequency .....	4
3. Testing Location.....	4
4. Test Facility and Configuration .....	5
5. Reference Calibration .....	6
6. Test Method .....	7
7. Measured Values and Calculation of Maximum Gain Positions.....	8
8. Summary of Test Result .....	9
9. Test Setup .....	10
10. Test Equipment and Calibration Data .....	11
11. Test Results .....	12





### 1. Operation Mode and Antenna Information

Antenna Position	RF Port	Brand Name	Model Name	Ant. Type	Connector	Modes of Operation
2G 5GAnt1	1	WNC	95XEAK15.003	PIFA	I-PEX	2.4GHz, 5GHz UNII1~3
2G 5GAnt2	2	WNC	95XEAK15.004	PIFA	I-PEX	2.4GHz, 5GHz UNII1~3

Note:

2.4GHz and 5GHz Operation Mode (2TX/2RX)

2G 5GAnt1~2 can be used as transmitting/receiving antenna.

2G 5GAnt1~2 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	Rex Liao	23.5-24.5 / 50-55	Mar. 23, 2022

Note:

Testing Site Information

Brand Name: TDK

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

Characteristic: Fully Anechoic Chamber

#### 4. Test Facility and Configuration

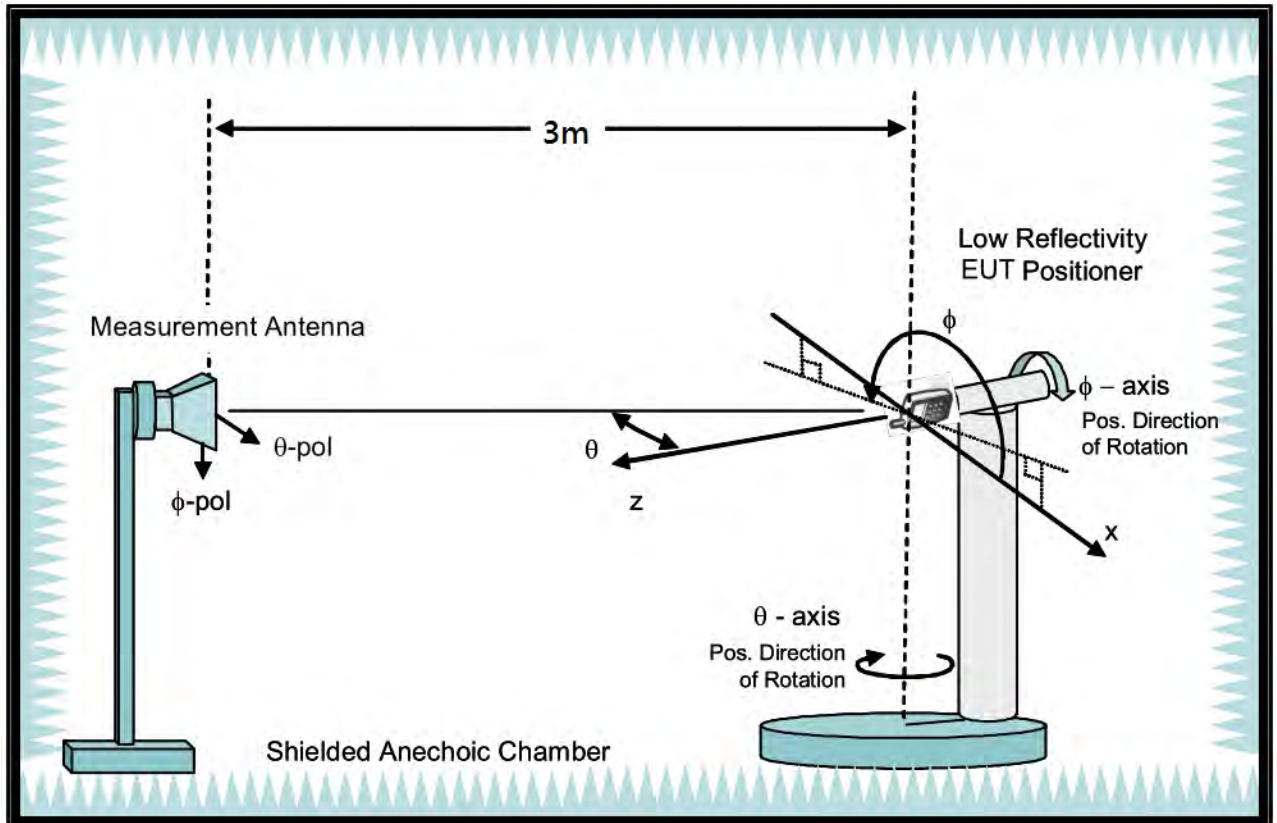
Test configuration: Reference to CITA OTA distributed-axes system configuration.

Chamber: Fully Anechoic Chamber.

Measurement antenna: Single Polarization Horn antenna calibrated according to ANSI C63.5.

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

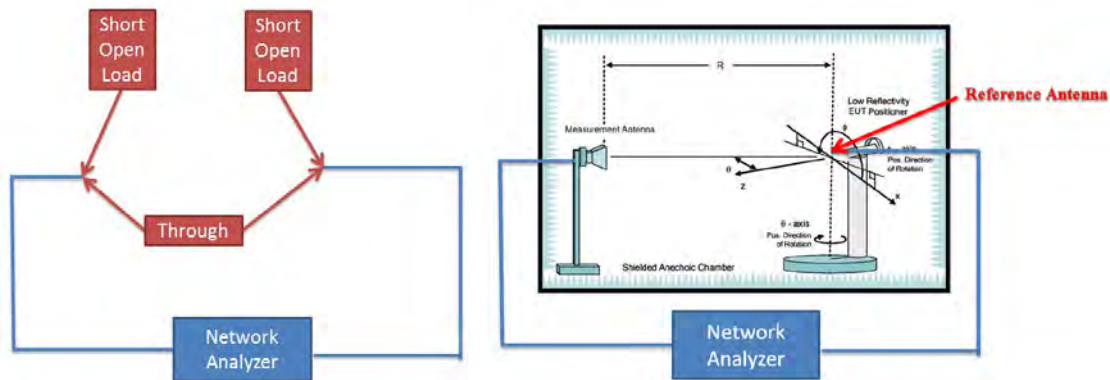
#Reference to CTIA “ctia-test-plan-for-wireless-device-over-the-air-performance-ver-3-7-1”



### 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 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)	2.45G	5.2G	5.3G	5.6G	5.785G
Ant. 1 (dBi)	-9.71	1.26	-5.52	-10.02	1.95
Ant. 2 (dBi)	5.52	-3.77	1.41	3.7	-4.64
DG [1SS] (dBi)	3.9	2.11	1.63	2.32	2.28
Polarization	Theta	Theta	Phi	Phi	Theta
Θ (°)	150	75	75	75	90
Φ (°)	30	90	105	30	90

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^(-9.71/20)	10^(1.26/20)	10^(-5.52/20)	10^(-10.02/20)	10^(1.95/20)
Ant. 2 [10^(G/20)]	10^(5.52/20)	10^(-3.77/20)	10^(1.41/20)	10^(3.7/20)	10^(-4.64/20)
Ant. 1 [10^(G/20)] value	0.327	1.156	0.53	0.316	1.252
Ant. 2 [10^(G/20)] value	1.888	0.648	1.176	1.531	0.586
Sum All Antenna [Amax]	2.215	1.804	1.706	1.847	1.838
DG [10*log(Amax^2/Nant)]	3.9	2.11	1.63	2.32	2.28

Note:

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

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





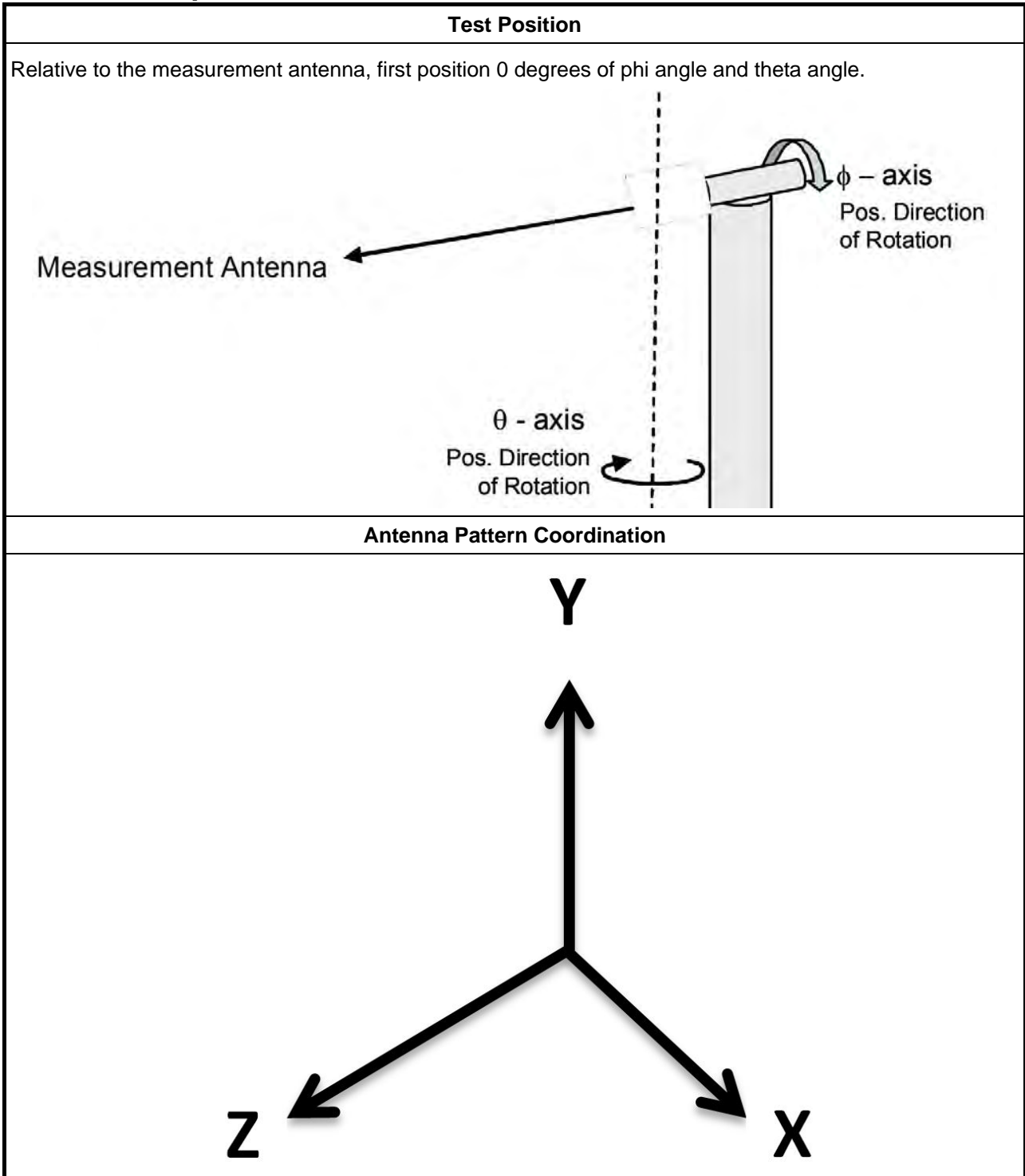
### 8. Summary of Test Result

Freq(Hz)	2.45G	5.2G	5.3G	5.6G	5.785G
Ant. 1 Max Gain (dBi)	3.63	1.56	1.04	1.91	2.22
Ant. 2 Max Gain (dBi)	5.52	1.11	1.56	3.7	3.41
Ant. 1 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Phi/75/60	Theta/75/105	Theta/45/135	Theta/60/120	Theta/60/105
Ant. 2 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/150/30	Phi/60/105	Phi/75/135	Phi/75/30	Phi/90/30
Max Gain (dBi)	5.52	1.56	1.56	3.7	3.41
DG [1SS] (dBi)	3.9	2.11	1.63	2.32	2.28

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.

### 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.

Appendix A – Radiated Composite Gain.....	Page 13
Appendix B – Antenna Pattern .....	Page 23
Appendix C – Test Photos.....	Page 28



## Radiated Composite Gain Data

## Appendix A

Freq(Hz)	2.45G	5.2G	5.3G	5.6G	5.785G
Ant. 1 Max Gain (dBi)	3.63	1.56	1.04	1.91	2.22
Ant. 2 Max Gain (dBi)	5.52	1.11	1.56	3.7	3.41
Ant. 1 Polarization/ $\theta(^{\circ})/\Phi(^{\circ})$	Phi/75/60	Theta/75/105	Theta/45/135	Theta/60/120	Theta/60/105
Ant. 2 Polarization/ $\theta(^{\circ})/\Phi(^{\circ})$	Theta/150/30	Phi/60/105	Phi/75/135	Phi/75/30	Phi/90/30
Max Gain (dBi)	5.52	1.56	1.56	3.7	3.41
DG [1SS] (dBi)	3.9	2.11	1.63	2.32	2.28





# Radiated Composite Gain Data

# Appendix A

Θ(165°)	-4.94	-5.06	-7.32	-10.13	-9.63	-6.11	-4.99	-8.27	-10.86	-8.95	-11.86	-16.49	-10.26	-6.77	-6.71	-8.31	-9.86	-12.33	-12.06	-12.69	-16.76	-17.77	-11.85	-7.46
Θ(180°)	-17.14	-13.03	-9.1	-7.16	-6.82	-6.46	-6.54	-6.74	-7.78	-10.1	-14.56	-17.28	-13.96	-9.38	-7.55	-5.93	-6.17	-7.41	-8.75	-9.57	-8.97	-9.95	-14.69	-18.22
Freq(Hz)	5.3G	Pol.	Phi	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DG(dBi)	Φ(0°)	Φ(15°)	Φ(30°)	Φ(45°)	Φ(60°)	Φ(75°)	Φ(90°)	Φ(105°)	Φ(120°)	Φ(135°)	Φ(150°)	Φ(165°)	Φ(180°)	Φ(195°)	Φ(210°)	Φ(225°)	Φ(240°)	Φ(255°)	Φ(270°)	Φ(285°)	Φ(300°)	Φ(315°)	Φ(330°)	Φ(345°)
Θ(0°)	-6.15	-3.41	-1.45	-0.58	-0.05	0.06	-0.38	-1.59	-3.87	-7.47	-11.85	-9.5	-5.51	-2.59	-1.34	-0.42	-0.26	-0.2	-0.95	-2.54	-4.74	-8.5	-12.98	-10.51
Θ(15°)	-6.55	-4.51	-2.56	-1.18	-0.02	0.05	-0.47	-2.29	-5.52	-10.99	-12.1	-8.09	-5.06	-2.65	-1.66	-0.67	-0.91	-1.09	-1.23	-1.5	-2.08	-4.1	-6.13	-7.41
Θ(30°)	-6.84	-7.01	-5.4	-3.19	-1.39	0.3	0.08	-1.11	-5.02	-9.24	-10.77	-11.86	-10.13	-7.63	-5.37	-3.77	-2.46	-1.74	-2.25	-2.77	-2.85	-2.87	-4.19	-6.57
Θ(45°)	-6.65	-6.06	-5.16	-4.9	-3.12	-1.23	0.51	-0.13	-2.02	-1.22	-1.8	-5.39	-7.63	-7.93	-4.19	-3.3	-5.16	-4.92	-4.47	-4.3	-3.86	-4.83	-8.4	-7.92
Θ(60°)	-0.28	0.67	0.54	-0.62	-1.92	-1.5	0.14	0.84	-0.83	0.39	-0.63	-3.98	-6.46	-5.55	-7.53	-3.29	-2.78	-7.8	-6.53	-5.37	-6.24	-11.3	-5.43	-1.77
Θ(75°)	-0.98	0.65	0.66	-1.94	-2.49	-0.89	1.62	1.63	-1.11	0.94	0.17	-2.53	-5.11	-6.7	-14.32	-5.45	-2.48	-6.48	-3.1	-6.45	-8.43	-9.61	-6.24	-2.87
Θ(90°)	-2.65	-2.35	-3.94	-5.47	-4.71	-3.13	-1.1	-0.68	-1.03	0.96	-0.99	-1.35	-2.13	-1.52	-2.91	-7.87	-7.83	-10.1	-7	-6.46	-7.43	-7.98	-4.5	-3.88
Θ(105°)	-2.68	-2.77	-3.73	-5.48	-5.22	-6.65	-4.41	-3.09	0.49	1.31	-3.26	-3.82	-2.92	-1.82	-3.64	-4.16	-4.49	-9.36	-11.07	-12.82	-7.26	-8.53	-5.37	-2.5
Θ(120°)	-2.05	-2.07	-3.54	-3.92	-4.61	-8.71	-5.73	-2.57	-2.57	-1.55	-3.1	-3.51	-3.86	-7.48	-6.74	-9.34	-11.07	-7.2	-14.75	-11.96	-6.93	-10.45	-4.72	-1.44
Θ(135°)	-10.24	-8.93	-8.55	-6.37	-4.77	-6.23	-4.19	-3	-5.14	-6.49	-6.85	-7.32	-5.29	-9.29	-10.37	-8.45	-12.34	-2.14	-8.84	-10.21	-4.69	-9.71	-13.63	-9.33
Θ(150°)	-4.16	-4.69	-4.19	-3.79	-4.02	-7.52	-6.56	-4.18	-2.66	-3.71	-4.34	-5.56	-3.99	-7.36	-10.33	-10.82	-9.14	-13.56	-18.06	-16.13	-8.14	-7.57	-5	-4.07
Θ(165°)	-5.15	-7.54	-6.59	-6.38	-7.45	-12.01	-15.88	-11.42	-8.46	-5.99	-4.99	-3.41	-2.52	-4.88	-8.14	-11.2	-14.59	-15.15	-16.59	-18.23	-13.29	-8.85	-6.24	-4.9
Θ(180°)	-8.85	-9.06	-10.52	-12.24	-18.94	-22.29	-17.2	-13.32	-10.3	-9.52	-10.03	-8.51	-7.95	-8.1	-10.16	-12.81	-18.54	-22.06	-18.17	-16.01	-12.94	-10.27	-9.56	-9.12
Freq(Hz)	5.3G	Pol.	Theta	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DG(dBi)	Φ(0°)	Φ(15°)	Φ(30°)	Φ(45°)	Φ(60°)	Φ(75°)	Φ(90°)	Φ(105°)	Φ(120°)	Φ(135°)	Φ(150°)	Φ(165°)	Φ(180°)	Φ(195°)	Φ(210°)	Φ(225°)	Φ(240°)	Φ(255°)	Φ(270°)	Φ(285°)	Φ(300°)	Φ(315°)	Φ(330°)	Φ(345°)
Θ(0°)	-0.78	-2.61	-4.8	-8.68	-11.6	-10.5	-6.17	-3.89	-1.91	-0.53	-0.5	-0.57	-1.3	-2.64	-5.44	-10.51	-13.1	-9.16	-5.55	-3.05	-1.28	-0.32	0.23	0.14
Θ(15°)	-1.57	-3.09	-4.97	-7.53	-8.29	-6.22	-3.96	-1.65	-0.92	-0.76	-1	-0.99	-1.35	-2.76	-4.77	-9.7	-17.37	-9.98	-5.55	-3.31	-1.74	-1.04	-0.43	-0.41
Θ(30°)	-2.8	-2.93	-3.96	-4.9	-4.22	-3.17	-2.22	-1.57	-1.59	-0.62	-0.02	-0.41	-0.92	-2.93	-5.83	-10.21	-8.72	-8.24	-5.01	-3.38	-3.94	-4.33	-4.52	-3.68
Θ(45°)	-3.49	-2.39	-2	-2.23	-2.52	-0.29	0.54	0.11	-0.47	0.33	-0.22	-1.94	-3.78	-6	-7.71	-10.75	-11.04	-6.25	-4.5	-6.53	-5.8	-3.69	-3.86	-3.13
Θ(60°)	-3.77	-3.32	-3.47	-4.11	-3.46	-3.39	-0.73	0.14	-1.17	-0.45	-0.99	-4.03	-7.41	-10.34	-9.59	-9	-10.32	-6.74	-6.77	-6.63	-6.7	-6.46	-4.99	-4.17
Θ(75°)	-5.2	-3.63	-3.37	-3.64	-2.85	-2.36	0.18	0.3	-2.39	-3.1	-5.39	-6.49	-5.9	-6.44	-8.02	-9.73	-11.1	-7.06	-9.47	-7.38	-7.14	-4.65	-4.09	-3.24
Θ(90°)	-4.49	-3.04	-1.98	-1.24	-2.24	-1.87	-1.24	0.14	-0.35	-2.7	-4.9	-5.37	-5.75	-7.35	-13.14	-9.94	-9.87	-8.21	-10.04	-8.78	-4.57	-4.13	-5.68	-3.28
Θ(105°)	-3.32	-1.57	-0.25	-1.04	-1.74	-0.72	-0.11	0.5	0.6	-1.04	-4.63	-8.71	-13	-12.39	-10.19	-8.12	-7.41	-6.32	-7.26	-7.56	-3.39	-4.88	-4.95	-2.67
Θ(120°)	-2.78	-1.64	-1.03	0.19	-0.21	-2.39	-2.22	-2.78	-4.55	-3.65	-3.57	-8.08	-12.17	-13.72	-12.19	-11.7	-14.98	-9.07	-10.09	-7.19	-10.12	-11.31	-5.45	-3.28
Θ(135°)	-9.24	-6.46	-3.6	-1.91	-1.14	-2.77	-1.19	-1.87	-2.6	-2.27	-2.97	-5.08	-6.7	-7.71	-18.09	-13.68	-8.25	-6.82	-7.26	-6.89	-7.77	-11.14	-10.47	-7.39
Θ(150°)	-4.42	-4.56	-5.21	-6.73	-5.84	-2.13	-1.46	-3.29	-4.87	-6.11	-9.16	-10.01	-15.66	-14.96	-18.86	-8.38	-7.04	-8.9	-10.94	-11.73	-15.3	-12.12	-11.06	-7.23
Θ(165°)	-6.08	-6.13	-8.01	-11.27	-8.61	-5.19	-4.64	-8.01	-11.26	-9.94	-10.64	-11.86	-10.78	-7.07	-5.29	-6.99	-9.88	-12.37	-11.78	-11.25	-14.83	-17.51	-13.13	-7.66
Θ(180°)	-23.15	-13.73	-11.16	-8.12	-7.18	-6.35	-7.29	-6.81	-7.76	-9.89	-11.7	-15.22	-17.29	-13.19	-8.75	-6.68	-7.35	-8.19	-9.34	-9.84	-9.33	-10.78	-13.21	-15.42
Freq(Hz)	5.6G	Pol.	Phi	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DG(dBi)	Φ(0°)	Φ(15°)	Φ(30°)	Φ(45°)	Φ(60°)	Φ(75°)	Φ(90°)	Φ(105°)	Φ(120°)	Φ(135°)	Φ(150°)	Φ(165°)	Φ(180°)	Φ(195°)	Φ(210°)	Φ(225°)	Φ(240°)	Φ(255°)	Φ(270°)	Φ(285°)	Φ(300°)	Φ(315°)	Φ(330°)	Φ(345°)
Θ(0°)	-6.37	-3.75	-1.79	-0.99	-0.78	-1.38	-2.12	-3.32	-6.37	-12.12	-12.52	-10.94	-7.04	-3.35	-1.05	-0.21	-0.05	-0.73	-1.82	-3.55	-6.35	-13.99	-13.35	-9.88
Θ(15°)	-5.1	-2.69	-1.7	-0.43	0.2	0.25	-0.07	-1.93	-5.74	-12.93	-15.49	-10.49	-6.62	-4.57	-3.38	-2.08	-1.85	-1.93	-3.09	-4.68	-6.76	-9.44	-9.01	-7.3
Θ(30°)	-5.7	-4.44	-2.34	-1.64	-0.84	-0.42	-0.9	-1.34	-4	-7.45	-9.85	-10.07	-8.69	-5.04	-4.04	-3.48	-3.6	-3.21	-2.54	-4.45	-6.9	-10.01	-9.31	-6.5
Θ(45°)	-4.23	-2.87	-1.66	-0.96	-1.15	-1.52	-0.11	0.17	-3.15	-5.92	-5.12	-5.8	-6.45	-6.45	-6.37	-4.76	-4.92	-4.64	-4.4	-6.38	-6.9	-8.25	-6.32	-7
Θ(60°)	-3.69	-2.45	-1.77	-0.7	0.18	-0.59	-2.7	0.03	-0.18	-1.73	-3	-4.02	-5.74	-6.13	-7.88	-6.48	-5.22	-6.18	-6.42	-14.21	-6.6	-5.13	-8.06	-6.64
Θ(75°)	-0.24	1.77	2.32	0.43	-1.85	-0.6	-2.3	-0.37	0.84	1.2	-1.05	-4.61	-4.41	-5.58	-8.74	-11.45	-5.84	-6.36	-8.91	-4.72	-6.09	-10	-4.44	-0.84
Θ(90°)	-2.29	0.12	1.56	0.84	-3.33	-1.9	0.38	0.46	-3.89	-0.31	-3.86	-6.22	-3.35	-1.31	-2.68	-11.61	-4.87	-10.22	-10.33	-5.54	-8.24	-7.92	-9.61	-4.6
Θ(105°)	-3.46	-3.66	-3.94	-2.15	-2.86	-4.12	-4.59	-6.18	-4.6	-0.9	-3.47	-3.29	-3.45	-3.66	-4.02	-8.7	-7.28	-11.55	-14.8	-10.57	-10.12	-15.1	-6.68	-4.81
Θ(120°)	-3.48	-2.89	-1.52	-0.79	-1.8	-3.76	-7.27	-5.47	-3.22	-4.78	-8.14	-5.81	-4.35	-5.33	-4.86	-7.6	-7.6	-6.41	-14.95	-15.31	-7.86	-10.56	-7.29	-4.09
Θ(135°)	-5.56	-6.17	-5.35	-3.96	-4.46	-9.38	-6.13	-3.18	-2.71	-1.77	-1.61	-4.04	-7.07	-10.29	-10.8	-11.61	-10.43	-5.04	-11.51	-8.24	-8.19	-9.88	-6.45	-5.05
Θ(150°)	-6.25	-5.91	-9.24	-10.91	-12.51	-10.87	-7.51	-5.59	-6.87	-8.33	-5.82	-5.89	-4.8	-7.6	-10.52	-12.8	-13.49	-14.57	-14.28	-11.12	-8.01	-9.77	-6.98	-8.59
Θ(165°)	-6.02	-8.94	-9.99	-8.18	-8.36	-11.56	-16.25	-14.33	-12	-9.81	-6.29	-2.91	-2.04	-4	-8.52	-11.11	-13.78	-18.05	-19.12	-19.13	-17.29	-10.93	-7.65	-5.94
Θ(180°)	-14.39	-14.48	-17.32	-17.38	-15.06	-14.89	-15.14	-14.34	-14.07	-14.81	-13.82	-13.78	-15.1	-12.77	-14.38	-14.55	-15.12	-15.41	-16.39	-18.52	-20.35	-15.97	-15.82	-17.07
Freq(Hz)	5.6G	Pol.	Theta	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DG(dBi)	Φ(0°)	Φ(15°)	Φ(30°)	Φ(45°)	Φ(60°)	Φ(75°)	Φ(90°)	Φ(105°)	Φ(120°)	Φ(135°)	Φ(150°)	Φ(165°)	Φ(180°)	Φ(195°)	Φ(210°)	Φ(225°)	Φ(240°)	Φ(255°)	Φ(270°)	Φ(285°)	Φ(300°)	Φ(315°)	Φ(330°)	Φ(345°)
Θ(0°)	-2.29	-3.68	-5.63	-10.5	-10.59	-9.55	-6.72	-4.3	-2.57	-1.16	-0.13	-0.25	-1.42	-3.52	-7.45	-12.71	-12.16	-9.86	-5.42	-3.26	-1.75	-0.31	-0.66	-0.87
Θ(15°)	-3.86	-6.27	-10.49	-14.83	-9.2	-6.75	-4.36	-2.18	-1.73	-1.25	-1.09	-1.95	-4.03	-6.12	-7.78	-12.34	-14.28	-8.2	-4.19	-2.4	-1.37	-0.9	-1.25	-2.09
Θ(30°)	-3.45	-5.28	-5.84	-6.2	-4.04	-2.56	-2.66	-1.46	-0.45	-0.15	-0.03	-0.86	-1.19	-4.45	-7.65	-9.44	-8.28	-5.18	-4.5	-3.65	-2.26	-2.96	-3.2	-3.98
Θ(45°)	-4.67	-2.81	-3.38	-2.33	-2.89	-3.23	-1.4	-0.11	0.24	0.06	-1.19	-2.7	-4.17	-5.62	-5.81	-7.62	-11.85	-8.73	-5.35					



# Radiated Composite Gain Data

# Appendix A

Θ(150°)	-10.41	-9.34	-10.41	-10.55	-6.5	-2.61	-0.55	-1.08	-2.91	-5.22	-6.63	-6.99	-10.94	-19.74	-18.68	-9.77	-9.73	-9.5	-11.15	-14.06	-17.34	-22.5	-17.55	-10.25
Θ(165°)	-9.32	-12.3	-11.87	-16.36	-11.58	-6.65	-5.54	-5.24	-7.17	-7.59	-7.08	-9.47	-10.7	-9.57	-7.27	-12.5	-17.44	-19.24	-11.99	-9.6	-13.48	-15.94	-14.18	-10.11
Θ(180°)	-23.13	-16.94	-15.1	-15.99	-15.63	-14.97	-12.16	-14.44	-14.8	-14.44	-12.34	-13.18	-14.75	-15.69	-12.99	-14.7	-17.63	-19.86	-23.34	-18.15	-17.64	-16.74	-14.44	-17.38
Freq(Hz)	5.785G	Pol.	Phi	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DG(dBi)	Φ(0°)	Φ(15°)	Φ(30°)	Φ(45°)	Φ(60°)	Φ(75°)	Φ(90°)	Φ(105°)	Φ(120°)	Φ(135°)	Φ(150°)	Φ(165°)	Φ(180°)	Φ(195°)	Φ(210°)	Φ(225°)	Φ(240°)	Φ(255°)	Φ(270°)	Φ(285°)	Φ(300°)	Φ(315°)	Φ(330°)	Φ(345°)
Θ(0°)	-2.99	-1.53	-0.28	-0.24	-0.27	-1.3	-2.49	-5.34	-9.47	-15.67	-18.54	-8.63	-4.19	-2.1	-0.5	-0.09	-0.13	-0.97	-2.51	-4.64	-9.1	-19.02	-13.62	-7.63
Θ(15°)	-3.46	-1.7	-0.21	0.32	0.35	0.19	-1.1	-2.56	-5.8	-12.73	-13.76	-9.14	-6.92	-6.16	-4.93	-4.04	-3.76	-3.23	-3.51	-4.79	-7.35	-17.51	-10.96	-5.89
Θ(30°)	-3.01	-1.7	-1.27	-1.07	-1.47	-1.32	-0.15	-1.21	-5.13	-8.36	-10.55	-6.5	-6.34	-5.99	-5.86	-4.95	-4.78	-5.61	-5.53	-5.29	-8.45	-10.66	-8.93	-5.45
Θ(45°)	-4.42	-3.04	-2.02	-0.31	-0.09	-0.31	0.73	1.83	-0.25	-6.64	-7.76	-5.56	-4.49	-4.32	-3.67	-4.23	-4.57	-5.36	-5.35	-5.96	-9.88	-8.67	-6.91	-5.78
Θ(60°)	-3.17	-1.79	-0.43	0.18	0.47	-1.63	-1.66	1.3	-1.41	-5.92	-2.89	-3.37	-7.22	-6.37	-6.81	-3.92	-5.83	-7.19	-8.51	-12.33	-12.37	-8.6	-8.28	-5.13
Θ(75°)	-0.92	-1.21	0.82	1.26	0.15	-0.28	-3.36	0.15	-0.35	0.27	-1.56	-3.7	-4.42	-5.73	-6.28	-10.03	-9.62	-5.45	-11.55	-8.52	-10.07	-8.21	-5.83	-1.01
Θ(90°)	-1.49	0.92	2.02	1.28	-2.16	-1.57	-3.27	0.05	-2.45	-0.92	-4.74	-8.15	-6.8	-3.75	-4.98	-13.22	-7.3	-12.57	-13.67	-7.09	-7.6	-7.34	-5.75	-3
Θ(105°)	-2.28	-0.88	-1.11	-3.15	-4.54	-3.89	-3.73	-3.25	-4.7	-0.24	-3.14	-6.68	-8.67	-7.81	-5.65	-6.87	-6.56	-9.5	-10.5	-9.33	-11.88	-7.74	-6.71	-3.59
Θ(120°)	-2.73	-0.41	-0.31	-1.38	-1.89	-3.45	-5.56	-5.31	-1.93	-4.58	-13.6	-11.02	-7.01	-6.94	-4.92	-8.51	-5.7	-6.67	-19.16	-10.18	-9.57	-11.24	-6.55	-4.09
Θ(135°)	-6.79	-4.36	-1.91	-1.27	-1.11	-4.94	-4.33	-3.63	-1.45	-1.67	-2.8	-4.93	-5.46	-10.39	-10.06	-8.97	-8.06	-3.9	-10.03	-8.13	-8.82	-10.7	-6.72	-4.64
Θ(150°)	-6	-6.09	-5.28	-4.54	-8.11	-8.6	-7.19	-3.44	-4.8	-8.04	-5.97	-5.59	-6.5	-7.57	-11.74	-16.37	-11.38	-13.71	-19.02	-12.37	-10.09	-10.84	-9.16	-7.7
Θ(165°)	-9.07	-10.53	-7.69	-7.62	-6.94	-9.06	-13.78	-10.55	-8.21	-9.12	-8.07	-5.67	-3.94	-3.85	-6.08	-8.08	-10.69	-14.52	-16.5	-19.83	-23.34	-13.39	-9.52	-8.82
Θ(180°)	-13.27	-14.44	-18.68	-19.54	-19.97	-16.93	-15.9	-14.34	-14.58	-15.03	-14.5	-14.68	-14.46	-14.3	-14.06	-15.63	-15.82	-14.15	-15.17	-17.31	-22.48	-20	-19.03	-14.37
Freq(Hz)	5.785G	Pol.	Theta	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DG(dBi)	Φ(0°)	Φ(15°)	Φ(30°)	Φ(45°)	Φ(60°)	Φ(75°)	Φ(90°)	Φ(105°)	Φ(120°)	Φ(135°)	Φ(150°)	Φ(165°)	Φ(180°)	Φ(195°)	Φ(210°)	Φ(225°)	Φ(240°)	Φ(255°)	Φ(270°)	Φ(285°)	Φ(300°)	Φ(315°)	Φ(330°)	Φ(345°)
Θ(0°)	-2.31	-3.95	-8.96	-18.27	-13.5	-6.6	-3.51	-1.76	-1.01	-0.56	-0.03	-0.8	-2.11	-5.01	-9.92	-22.24	-12.03	-6.24	-3.51	-1.99	-1.28	-0.25	-0.02	-0.74
Θ(15°)	-3.14	-5.54	-8.25	-10.72	-6.73	-3.89	-2.51	-2.2	-1.55	-1.92	-2.85	-3.6	-6.36	-10.07	-15.26	-18.95	-10.86	-7.52	-4.15	-3.07	-1.39	-0.43	-0.91	-2.19
Θ(30°)	-6.84	-6.29	-5.57	-3.19	-2.4	-1.71	-0.51	-0.31	-1.74	-1.23	-0.94	-1.33	-2	-4.13	-8.32	-11.2	-11.08	-8.08	-4.66	-2.27	-2.5	-3.24	-4.77	-6.56
Θ(45°)	-6.52	-4.77	-3.25	-1.37	-0.81	-1.25	-1.9	0.04	0.72	1.04	0.04	-2.12	-3.61	-5.71	-7.92	-8.66	-7.58	-6.58	-5.13	-5.34	-6.09	-6.94	-6.39	-6.86
Θ(60°)	-2.28	-0.98	-0.26	-0.28	-1.44	-3.97	-1.28	0.98	0.05	-0.28	-1.75	-3.86	-5.39	-8.22	-9.56	-9.16	-13	-8.2	-8.94	-10.67	-7.38	-4.63	-4.33	-4.1
Θ(75°)	-2.18	-1.91	-2.68	-3.68	-2.04	-0.72	-0.92	-0.64	-1.45	-1.88	-3.08	-5.5	-6.19	-9.04	-13.38	-12.97	-13.89	-15.2	-11.37	-9.54	-5.47	-4.6	-4.62	-2.6
Θ(90°)	-1.56	-1.32	-2	-3.06	-1.46	0.34	2.28	1.73	-0.52	-1.37	-5.52	-9.97	-8.21	-13.01	-14.09	-12.29	-10.69	-15.48	-9.98	-6.56	-4.56	-4.7	-3.83	-0.65
Θ(105°)	-2.92	-2.88	-2.93	-2.62	-3.46	-1.07	0.85	0.94	-1.54	-1.47	-2.98	-7.28	-13.38	-15.17	-16.07	-9.9	-11.36	-12.37	-6.45	-7.85	-6.11	-5.2	-5.06	-1.64
Θ(120°)	-7.34	-8.04	-8.35	-7.75	-5.78	-4.15	-2.73	0.67	0.42	-1.62	-6.23	-8.58	-11.42	-15.73	-14.81	-13.55	-16.02	-13.71	-13.93	-8.5	-11.08	-12.34	-12.54	-5.97
Θ(135°)	-11.71	-7.94	-6.58	-6.79	-4.72	-2.15	-1.69	-1.44	-2.69	-3.22	-4.51	-6.06	-9.62	-8.3	-13.36	-9.69	-16.3	-10.46	-12.47	-15.49	-9.49	-9.99	-13.01	-9.24
Θ(150°)	-19.26	-15.04	-13.36	-10.43	-6.65	-1.61	0.73	-0.7	-1.74	-4.09	-7.03	-7.25	-12.02	-12.67	-14.39	-13.2	-10.39	-13.1	-13.81	-18.61	-17.56	-17.33	-17.41	-21.71
Θ(165°)	-9.97	-7.99	-7.47	-10.94	-10.34	-7.6	-6.13	-6.55	-10.76	-9.87	-7.56	-9	-11.78	-9.42	-7.31	-9.95	-14.55	-18.93	-13.23	-13.68	-19.8	-16.94	-12.99	-10.75
Θ(180°)	-21.29	-15.59	-15.4	-15.04	-16.41	-16.83	-18.42	-19.6	-14.03	-11.68	-10.46	-13.94	-18.07	-18.88	-19.6	-18.26	-23	-23.32	-17.43	-15.17	-18.83	-18.6	-18.6	-17.68





Gain Result

Table with columns: Freq(Hz), Gain, Pol., Phi, Ant. 1, and various Phi angles (0 to 345 degrees). It contains three main sections of data for frequencies 2.45G, 5.2G, and 5.2G.









Radiated Composite Gain Data

Appendix A

Table with 25 columns and 248 rows of data. Columns include Gain values for various frequencies (5.6G, 5.785G) and angles (Theta, Phi). Rows are grouped by frequency and angle. Some cells contain values in red (e.g., 3.7, 3.41, -1.42, -1.15).



**Radiated Composite Gain Data**

**Appendix A**

Θ (105°)	-2.71	-3.42	-4.22	-5.65	-8.5	-9.12	-6.89	-6.83	-14.39	-10.79	-10.46	-15.92	-27.88	-19.84	-17.45	-17.81	-15.64	-12.1	-9.24	-6.13	-7.45	-7.13	-4.47	-1.75
Θ (120°)	-6.65	-6.88	-9.3	-11.21	-10.38	-13.58	-25.65	-9.85	-9.55	-12.63	-21.34	-18.71	-20.77	-18.6	-22.48	-21.93	-18.79	-16.54	-27.98	-12.48	-12.88	-12.79	-11.37	-5.46
Θ (135°)	-10.69	-10.48	-15.52	-18.8	-13.94	-11.42	-13.73	-15	-13.99	-12.6	-10.17	-9.12	-13.94	-17.48	-28.2	-22.39	-16.82	-12.59	-17.06	-15.36	-21.46	-13.17	-13.61	-10.33
Θ (150°)	-26.36	-27.49	-28.17	-27.83	-23.29	-12.96	-6.54	-8.78	-12.76	-15.7	-16.22	-12.12	-21.65	-16.14	-21.04	-17.32	-16.91	-18.19	-21.58	-24.35	-22.02	-21.15	-21.63	-22.47
Θ (165°)	-13.97	-10.16	-9.35	-12.34	-12.21	-12.42	-11.81	-11.81	-16.89	-23.09	-18.6	-17.11	-22.85	-25.15	-20.32	-19.85	-26.24	-28.42	-19.65	-20.38	-28.74	-26.13	-17.7	-13.81
Θ (180°)	-26.9	-21.8	-28.03	-27.95	-28.08	-28.99	-28.38	-28.79	-19.96	-14.73	-11.77	-16	-18.62	-19.31	-19.8	-23.74	-24.41	-24.98	-17.19	-15.55	-18.18	-21.21	-21.43	-20.18









Antenna Pattern

Appendix B

Gain	Φ(0°)	Φ(15°)	Φ(30°)	Φ(45°)	Φ(60°)	Φ(75°)	Φ(90°)	Φ(105°)	Φ(120°)	Φ(135°)	Φ(150°)	Φ(165°)	Φ(180°)	Φ(195°)	Φ(210°)	Φ(225°)	Φ(240°)	Φ(255°)	Φ(270°)	Φ(285°)	Φ(300°)	Φ(315°)	Φ(330°)	Φ(345°)
Θ(165°)	-6.89	-7.90	-8.89	-11.67	-12.09	-11.76	-9.78	-9.24	-12.22	-13.08	-12.34	-9.24	-8.10	-10.89	-12.05	-14.98	-15.08	-15.79	-13.18	-12.73	-13.96	-11.44	-10.33	-8.53
Θ(180°)	-15.44	-15.15	-15.58	-15.65	-15.84	-14.80	-13.98	-14.99	-14.25	-13.28	-11.14	-11.28	-10.88	-10.89	-11.35	-13.62	-14.69	-15.56	-15.65	-15.87	-14.28	-14.17	-14.38	-16.04
Freq(Hz)	5.785G	Pol.	Total	Ant. 2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Θ(0°)	-4.31	-3.85	-4.52	-4.98	-5.64	-6.02	-6.12	-6.18	-6.89	-6.30	-5.11	-5.66	-4.96	-5.49	-5.52	-5.59	-5.30	-5.02	-5.37	-5.22	-6.00	-4.90	-4.62	-4.56
Θ(15°)	-6.79	-7.37	-6.58	-5.16	-4.44	-3.66	-3.50	-4.20	-6.76	-10.75	-11.85	-9.68	-11.58	-14.17	-13.81	-11.02	-9.87	-7.21	-4.76	-5.91	-6.04	-6.09	-7.86	-7.76
Θ(30°)	-5.35	-4.88	-5.00	-3.47	-3.25	-2.59	-1.30	-1.90	-5.16	-7.33	-6.71	-5.80	-5.54	-6.56	-8.42	-9.37	-8.14	-7.61	-5.66	-5.26	-8.23	-10.65	-9.83	-9.36
Θ(45°)	-4.38	-3.44	-2.56	-1.21	-0.31	-0.14	0.31	1.95	0.17	-4.68	-5.92	-6.33	-8.08	-9.74	-9.32	-9.98	-7.31	-7.25	-5.19	-7.57	-10.49	-10.85	-8.87	-6.32
Θ(60°)	0.28	1.38	1.91	0.89	0.47	0.13	-1.44	1.44	-1.19	-4.30	-2.65	-4.37	-6.23	-8.30	-13.60	-8.36	-9.28	-9.58	-8.51	-12.99	-12.94	-9.15	-4.99	-1.69
Θ(75°)	1.78	2.31	3.51	2.80	0.64	1.08	-1.60	0.36	-1.55	0.50	-0.08	-2.60	-3.68	-4.95	-8.25	-12.61	-11.22	-11.70	-11.51	-12.89	-6.30	-5.15	-2.43	0.90
Θ(90°)	1.66	3.42	4.39	3.28	-0.28	0.59	-1.15	2.13	-2.82	-0.09	-3.95	-7.14	-5.24	-3.14	-4.23	-15.07	-7.42	-13.46	-12.08	-5.21	-3.14	-3.65	-2.09	1.38
Θ(105°)	0.08	0.83	0.56	-0.53	-1.40	-1.82	-1.17	-0.19	-5.38	-0.64	-4.34	-8.53	-7.42	-6.67	-7.08	-14.77	-7.26	-8.30	-6.37	-5.62	-5.64	-6.07	-2.69	0.05
Θ(120°)	-1.24	0.02	-0.61	-0.16	-0.31	-2.15	-3.75	-5.62	-3.69	-5.36	-13.39	-12.52	-8.21	-9.94	-11.51	-13.93	-10.92	-9.06	-15.92	-9.20	-7.42	-11.11	-5.73	-1.82
Θ(135°)	-5.94	-3.89	-1.58	-0.32	-0.74	-2.84	-3.72	-5.28	-3.90	-5.17	-6.30	-7.67	-11.09	-15.31	-15.65	-11.25	-12.40	-11.47	-14.74	-9.75	-12.24	-9.72	-9.10	-4.63
Θ(150°)	-6.08	-4.09	-4.71	-5.08	-8.79	-6.89	-4.05	-4.64	-9.50	-13.35	-8.25	-6.24	-11.32	-12.42	-15.57	-14.94	-13.92	-12.82	-15.49	-15.14	-15.64	-14.38	-12.81	-9.44
Θ(165°)	-9.75	-6.72	-5.80	-8.12	-8.16	-8.57	-9.03	-9.24	-12.71	-15.61	-15.45	-14.50	-13.48	-13.11	-13.74	-14.19	-13.90	-15.64	-15.13	-15.62	-15.75	-15.80	-13.76	-11.38
Θ(180°)	-16.14	-15.65	-15.75	-15.43	-15.35	-16.14	-15.32	-15.87	-14.85	-13.12	-10.87	-13.78	-14.99	-15.18	-14.57	-15.65	-14.12	-13.19	-13.83	-13.58	-15.51	-15.00	-14.99	-15.51

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

