



# Antenna Composite Gain Test Report

FCC ID	2ABLKU10XE
Equipment	GigaSpire BLAST u10xe
Brand Name	Calix
Model Name	u10xe GS4237
Applicant	Calix Inc. 1035 N. McDowell Blvd. Petaluma, CA94954 U.S.A
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	Nov. 15, 2022
Start Test Date	Dec. 08, 2022
Final Test Date	Dec. 08, 2022

Approved by: Rex Liao

**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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### History of this test report

Report No.	Version	Description	Issued Date
AP2N1015	01	Initial issue of report	May 24, 2023
AP2N1015	02	Changing equipment name	Jun. 02, 2023



### 1. Operation Mode and Antenna Information

Antenna Position	RF Port		Brand Name	Model Name	Ant. Type	Connector	Modes of Operation
	WLAN 2.4GHz	WLAN 5GHz					
2G 5G Ant1	1	3	WNC	81XKAC15.GFB	Dipole	I-PEX	2.4GHz / 5GHz UNII 1~3
2G 5G Ant2	2	4	WNC	81XKAC15.GFC	Dipole	I-PEX	
5G Ant3	-	1	WNC	81XKAC15.GGA	Dipole	I-PEX	5GHz UNII 1~3
5G Ant4	-	2	WNC	81XKAC15.GGA	Dipole	I-PEX	

Note:

2.4GHz Operation Mode (2TX/2RX)

2G 5G Ant1~2 can be used as transmitting/receiving antenna.

2G 5G Ant1~2 could transmit/receive simultaneously.

5GHz Operation Mode (4TX/4RX)

2G 5G Ant1~4 can be used as transmitting/receiving antenna.

2G 5G Ant1~4 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		
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 / 50~55	Dec. 08, 2022

Note:

Testing Site Information

Brand Name: TDK

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

Characteristic: Fully Anechoic Chamber

#### 4. Test Facility and Configuration

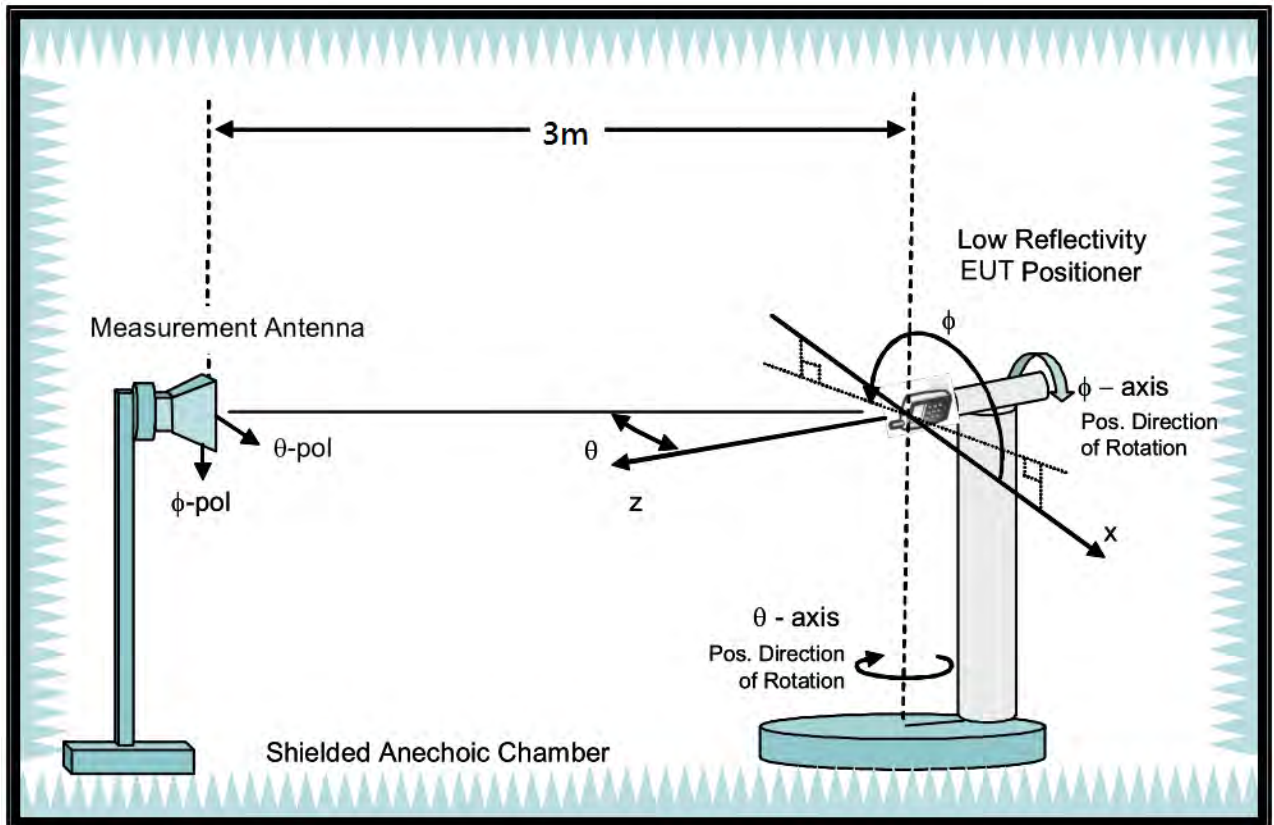
Test configuration: Reference to CITA OTA distributed-axes system configuration.

Chamber: Fully Anechoic Chamber.

Measurement antenna: Dual Polarization Horn antenna

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

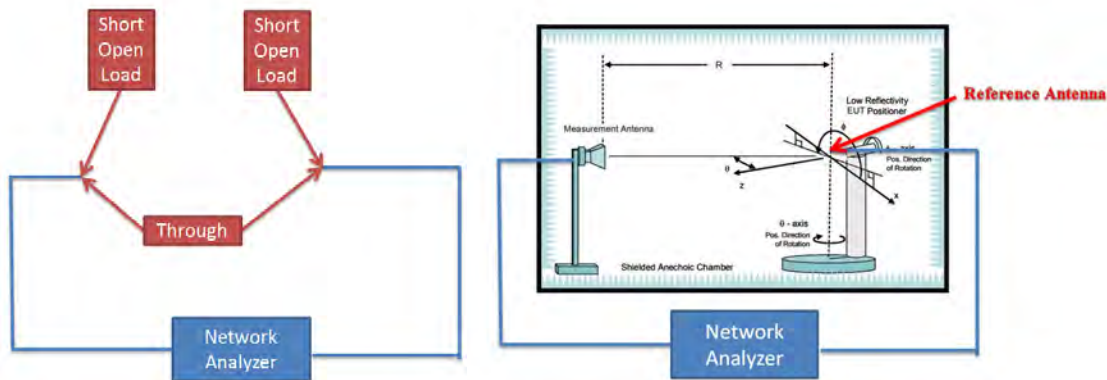
#Reference to CTIA “ctia-test-plan-for-wireless-device-over-the-air-performance-ver-3-7-1”



### 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
Ant. 1 (dBi)	1.83	-3.02	0.01	0.8	0.56
Ant. 2 (dBi)	1.67	-2.85	-3.26	-1.82	-3.45
Ant. 3 (dBi)		-1.48	-3.15	2.99	2.85
Ant. 4 (dBi)		-3.58	-0.8	0.33	2.8
DG [1SS] (dBi)	4.76	3.32	4.34	6.76	7.06
Polarization	Theta	Theta	Theta	Theta	Theta
Θ(°)	82.5	97.5	97.5	97.5	112.5
Φ(°)	285	90	300	0	82.5

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^(1.83/20)	10^(-3.02/20)	10^(0.01/20)	10^(0.8/20)	10^(0.56/20)
Ant. 2 [10^(G/20)]	10^(1.67/20)	10^(-2.85/20)	10^(-3.26/20)	10^(-1.82/20)	10^(-3.45/20)
Ant. 3 [10^(G/20)]		10^(-1.48/20)	10^(-3.15/20)	10^(2.99/20)	10^(2.85/20)
Ant. 4 [10^(G/20)]		10^(-3.58/20)	10^(-0.8/20)	10^(0.33/20)	10^(2.8/20)
Ant. 1 [10^(G/20)] value	1.235	0.706	1.001	1.096	1.067
Ant. 2 [10^(G/20)] value	1.212	0.72	0.687	0.811	0.672
Ant. 3 [10^(G/20)] value		0.843	0.696	1.411	1.388
Ant. 4 [10^(G/20)] value		0.662	0.912	1.039	1.38
Sum All Antenna [Amax]	2.447	2.932	3.296	4.357	4.508
DG [10*log(Amax^2/Nant)]	4.76	3.32	4.34	6.76	7.06

Note:

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

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





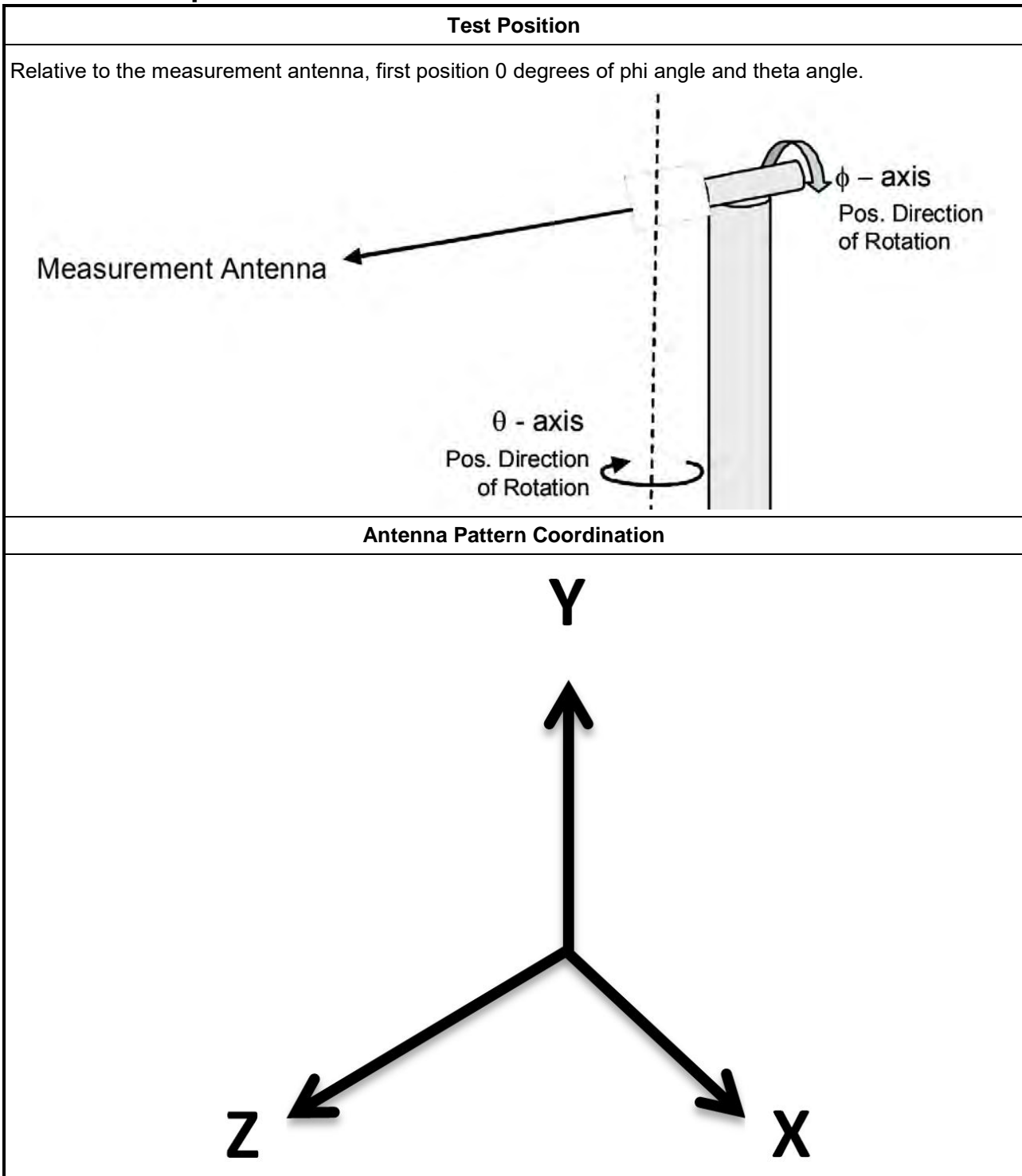
8. Summary of Test Result

Freq(Hz)	2.45G	5.2G	5.3G	5.6G	5.785G
Ant. 1 Max Gain (dBi)	2.88	0.9	1.02	3.27	1.99
Ant. 2 Max Gain (dBi)	3.07	0.72	0.74	2.25	1.46
Ant. 3 Max Gain (dBi)		1.13	2	2.99	3.26
Ant. 4 Max Gain (dBi)		0.82	1.2	1.82	2.95
Ant. 1 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/105/97.5	Theta/105/37.5	Theta/90/300	Theta/97.5/97.5	Theta/82.5/105
Ant. 2 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/112.5/255	Theta/97.5/255	Theta/90/82.5	Theta/105/255	Theta/97.5/255
Ant. 3 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$		Theta/52.5/75	Theta/52.5/75	Theta/97.5/0	Theta/105/352.5
Ant. 4 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$		Phi/135/45	Phi/127.5/30	Phi/120/0	Theta/112.5/75
Max Gain (dBi)	3.07	1.13	2	3.27	3.26
DG [1SS] (dBi)	4.76	3.32	4.34	6.76	7.06
DG [2SS] (dBi)	3.07	1.13	2	3.76	4.06
DG [4SS] (dBi)		1.13	2	3.27	3.26

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	MY46419477	100kHz~8.5GHz	July. 20, 2022	July. 19, 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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Appendix C – Test Photos.....	Page 34



Freq(Hz)	2.45G	5.2G	5.3G	5.6G	5.785G
Ant. 1 Max Gain (dBi)	2.88	0.9	1.02	3.27	1.99
Ant. 2 Max Gain (dBi)	3.07	0.72	0.74	2.25	1.46
Ant. 3 Max Gain (dBi)		1.13	2	2.99	3.26
Ant. 4 Max Gain (dBi)		0.82	1.2	1.82	2.95
Ant. 1 Polarization/ $\theta(^{\circ})/\Phi(^{\circ})$	Theta/105/97.5	Theta/105/37.5	Theta/90/300	Theta/97.5/97.5	Theta/82.5/105
Ant. 2 Polarization/ $\theta(^{\circ})/\Phi(^{\circ})$	Theta/112.5/255	Theta/97.5/255	Theta/90/82.5	Theta/105/255	Theta/97.5/255
Ant. 3 Polarization/ $\theta(^{\circ})/\Phi(^{\circ})$		Theta/52.5/75	Theta/52.5/75	Theta/97.5/0	Theta/105/352.5
Ant. 4 Polarization/ $\theta(^{\circ})/\Phi(^{\circ})$		Phi/135/45	Phi/127.5/30	Phi/120/0	Theta/112.5/75
Max Gain (dBi)	3.07	1.13	2	3.27	3.26
DG [1SS] (dBi)	4.76	3.32	4.34	6.76	7.06
DG [2SS] (dBi)	3.07	1.13	2	3.76	4.06
DG [4SS] (dBi)		1.13	2	3.27	3.26







Radiated Composite Gain Data

Appendix A

Table with columns for frequency (Freq[Hz]), phase angle (Theta), and various gain measurements (Phi) for different antenna configurations. Includes values for 5.785GHz and various phase angles from 0 to 180 degrees.







# Radiated Composite Gain Data

# Appendix A

Theta	Phi	Gain	Phi(7.5)	Phi(15)	Phi(30)	Phi(45)	Phi(60)	Phi(75)	Phi(90)	Phi(105)	Phi(120)	Phi(135)	Phi(150)	Phi(165)	Phi(180)	Phi(195)	Phi(210)	Phi(225)	Phi(240)	Phi(255)	Phi(270)	Phi(285)	Phi(300)	Phi(315)	Phi(330)	Phi(345)
Theta(°)	Phi(°)	Gain	Phi(7.5)	Phi(15)	Phi(30)	Phi(45)	Phi(60)	Phi(75)	Phi(90)	Phi(105)	Phi(120)	Phi(135)	Phi(150)	Phi(165)	Phi(180)	Phi(195)	Phi(210)	Phi(225)	Phi(240)	Phi(255)	Phi(270)	Phi(285)	Phi(300)	Phi(315)	Phi(330)	Phi(345)
Theta(°)	Phi(°)	Gain	Phi(7.5)	Phi(15)	Phi(30)	Phi(45)	Phi(60)	Phi(75)	Phi(90)	Phi(105)	Phi(120)	Phi(135)	Phi(150)	Phi(165)	Phi(180)	Phi(195)	Phi(210)	Phi(225)	Phi(240)	Phi(255)	Phi(270)	Phi(285)	Phi(300)	Phi(315)	Phi(330)	Phi(345)
Theta(°)	Phi(°)	Gain	Phi(7.5)	Phi(15)	Phi(30)	Phi(45)	Phi(60)	Phi(75)	Phi(90)	Phi(105)	Phi(120)	Phi(135)	Phi(150)	Phi(165)	Phi(180)	Phi(195)	Phi(210)	Phi(225)	Phi(240)	Phi(255)	Phi(270)	Phi(285)	Phi(300)	Phi(315)	Phi(330)	Phi(345)





# Radiated Composite Gain Data

# Appendix A

Freq(Hz)	Theta	Phi	Phi(2)	Phi(3)	Phi(4)	Phi(5)	Phi(6)	Phi(7)	Phi(8)	Phi(9)	Phi(10)	Phi(11)	Phi(12)	Phi(13)	Phi(14)	Phi(15)	Phi(16)	Phi(17)	Phi(18)	Phi(19)	Phi(20)	Phi(21)	Phi(22)	Phi(23)	Phi(24)	Phi(25)	Phi(26)	Phi(27)	Phi(28)	Phi(29)	Phi(30)	Phi(31)	Phi(32)	Phi(33)	Phi(34)	Phi(35)												
Theta(10°)	-15.79	-16.23	-19.04	-18.61	-17.89	-13.16	-16.78	-18.65	-18.93	-15.78	-13.49	-19.01	-16.31	-13.15	-13.41	-16.63	-17.91	-15.19	-14.59	-16.79	-17.91	-17.75	-17.55	-15.73	-18.21	-18.64	-18.61	-18.32	-18.15	-15.91	-15.03	-19.13	-18.18	-19.11	-17.62	-13.48	-12.98	-14.11	-19.12	-18.64	-16.44	-15.44	-17.65	-14.51	-14.96	-17.19	-15.04	
Theta(112.5°)	-18.38	-18.17	-18.45	-15.99	-13.88	-18.18	-18.26	-16.43	-14.86	-11.98	-13.94	-18.33	-18.16	-14.11	-15.58	-17.43	-13.04	-17.11	-19.05	-19.14	-17.81	-18.02	-15.37	-16.15	-18.94	-17.42	-18.28	-14.89	-13.06	-18.17	-18.62	-18.19	-17.18	-18.69	-13.49	-14.21	-12.53	-13.94	-18.89	-16.31	-12.63	-15.21	-14.44	-18.21	-17.68	-17.37	-14.71	-18.71
Theta(120°)	-17.78	-18.22	-17.69	-17.29	-18.39	-18.97	-17.44	-18.44	-16.54	-16.57	-12.32	-15.61	-12.98	-15.18	-13.37	-14.65	-18.43	-18.79	-15.12	-13.09	-16.68	-17.82	-15.83	-18.35	-17.33	-18.11	-17.72	-18.23	-14.48	-14.32	-13.04	-18.11	-18.63	-18.75	-18.08	-15.34	-14.12	-13.72	-18.97	-17.37	-13.89	-17.77	-18.46	-13.22	-15.12	-17.19	-14.71	
Theta(127.5°)	-17.22	-18.65	-17.71	-18.99	-15.11	-16.57	-18.85	-18.12	-13.79	-12.01	-13.91	-17.26	-18.14	-16.46	-11.81	-14.26	-19.06	-17.96	-14.04	-12.58	-14.21	-14.77	-17.91	-18.83	-16.97	-18.78	-18.55	-18.09	-15.35	-12.66	-18.51	-16.11	-18.69	-12.9	-18.83	-19.05	-14.15	-10.78	-16.61	-19.7	-14.74	-13.95	-19.09	-17.28	-18.53	-18.05	-18.31	-18.65



Radiated Composite Gain Data

Appendix A

Table with 25 columns for frequency (MHz) and 25 columns for gain (dBi) at various angles. Rows include frequency bands (Theta, Phi), gain data for various angles, and a final section with 'not found' entries.



Radiated Composite Gain Data

Appendix A

Table with columns for Frequency (MHz), Gain, and various Theta/Phi angles (Theta(0) to Theta(180) and Phi(0) to Phi(355)). It contains numerical gain data for a wide range of frequencies from 5.20 to 5.35 GHz.

