




Antenna Composite Gain Test Report

Equipment	Access Point
Brand Name	 Extreme networks or Extreme Networks
Model Name	AP3000-WW, AP3000X-WW
Applicant	Extreme Networks, Inc. 2121 RDU Center Drive, Morrisville, NC 27560, United States
Manufacturer	Extreme Networks, Inc. 2121 RDU Center Drive, Morrisville, NC 27560, United States
Sample Received	Apr. 07, 2022
Start Test Date	Apr. 14, 2022
Final Test Date	Apr. 14, 2022



Approved by: Jackson Tsai

SPORTON INTERNATIONAL INC. Hsinhua Laboratory

No.52, Huaya 1st Rd., Guishan Dist., Taoyuan City 333411, Taiwan (R.O.C.)



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1. Operation Mode and Antenna Information

Antenna Position	RF Port	Brand Name	Model Name	Ant. Type	Connector	Modes of Operation
2G 5GAnt1	1	Senao	5718A0691300	PIFA	I-PEX	2.4GHz, 5GHz
2G 5GAnt2	2	Senao	5718A0690300	PIFA	I-PEX	2.4GHz, 5GHz

Note:

2.4GHz and 5GHz Operation Mode (1TX/2RX)

2G 5GAnt1~2G 5GAnt2 can be used as transmitting/receiving antenna.

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

2G 5GAnt1~2G 5GAnt2 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

Test Lab. : Sporton International Inc. Hsinhua Laboratory				
<input checked="" type="checkbox"/> 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	20~21°C / 40~45%	14/Apr/2022

Note:

Testing Site Information

Brand Name: TDK

Dimension: 11m*6m*6m

Characteristic: Fully Anechoic Chamber

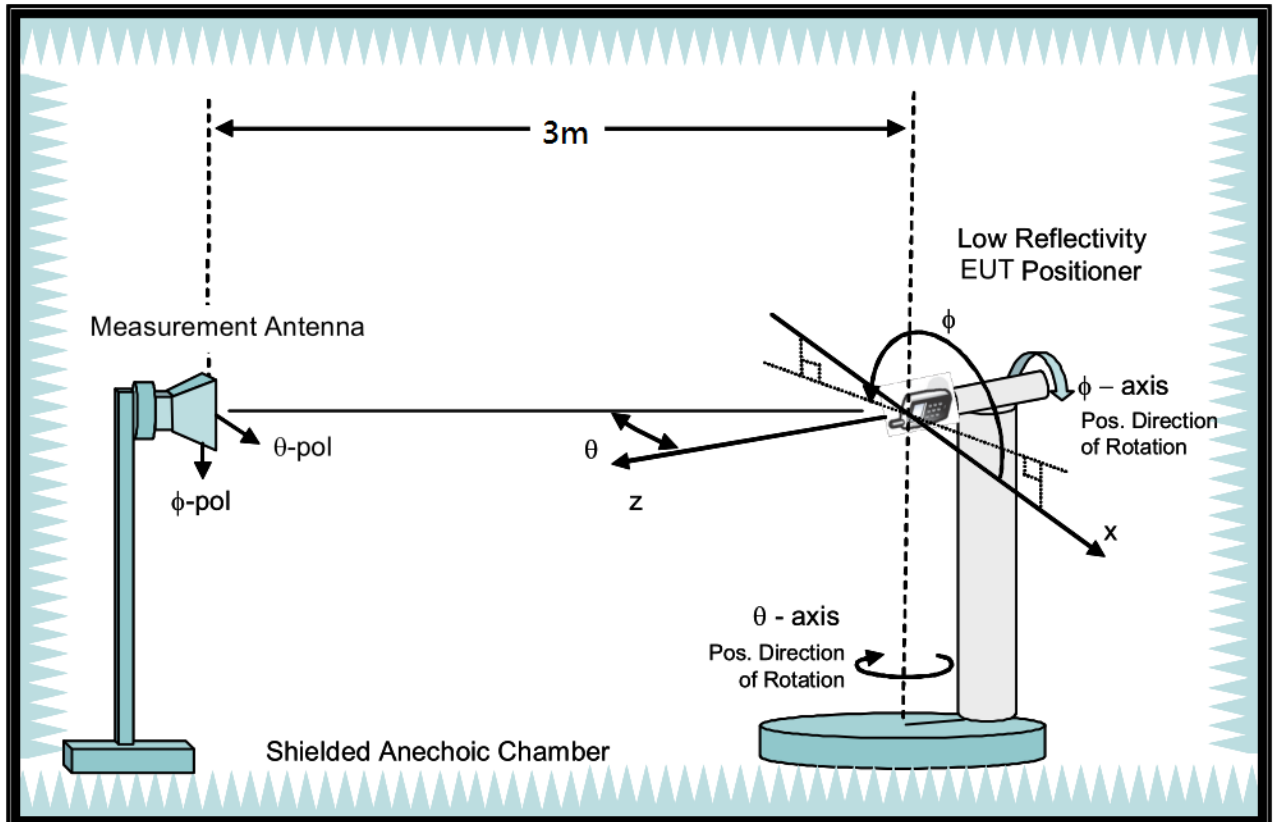
4. Test Facility and Configuration

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.

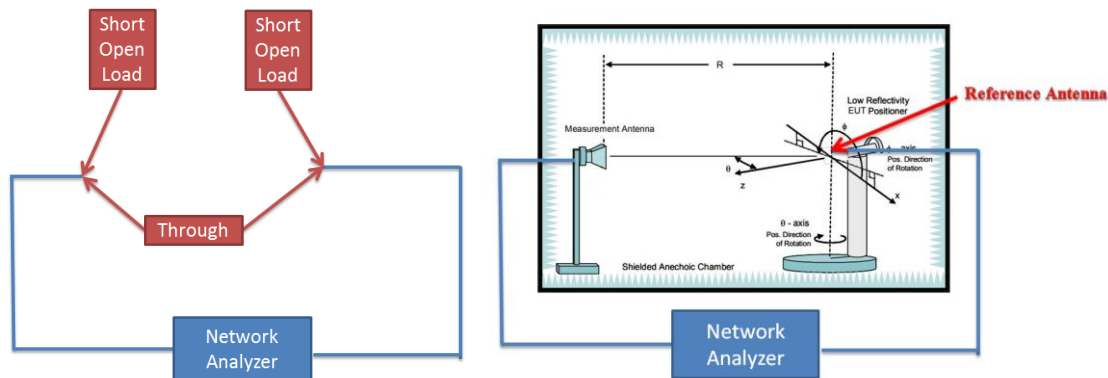
#Reference to CTIA “ctia-test-plan-for-wireless-device-over-the-air-performance-ver-3-7-1”



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:

$$G \text{ reading (dB)} = 20 \cdot \log(V2/V1) = 10 \cdot \log(P2/P1)$$

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)	2.31	2.12	-2.23	2.65	-3.02
Ant. 2 (dBi)	3.33	0.55	4.74	-0.96	4.12
DG [1SS] (dBi)	5.85	4.38	4.95	4.04	4.27
Polarization	Theta	Theta	Theta	Theta	Theta
Θ (°)	80	50	50	40	60
Φ (°)	240	240	140	180	140

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 [$10^{(G/20)}$]	$10^{(2.31/20)}$	$10^{(2.12/20)}$	$10^{(-2.23/20)}$	$10^{(2.65/20)}$	$10^{(-3.02/20)}$
Ant. 2 [$10^{(G/20)}$]	$10^{(3.33/20)}$	$10^{(0.55/20)}$	$10^{(4.74/20)}$	$10^{(-0.96/20)}$	$10^{(4.12/20)}$
Ant. 1 [$10^{(G/20)}$] value	1.305	1.276	0.774	1.357	0.706
Ant. 2 [$10^{(G/20)}$] value	1.467	1.065	1.726	0.895	1.607
Sum All Antenna [Amax]	2.772	2.342	2.499	2.252	2.313
DG [$10 \cdot \log(A_{max}^2/N_{ant})$]	5.85	4.38	4.95	4.04	4.27

Note:

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

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



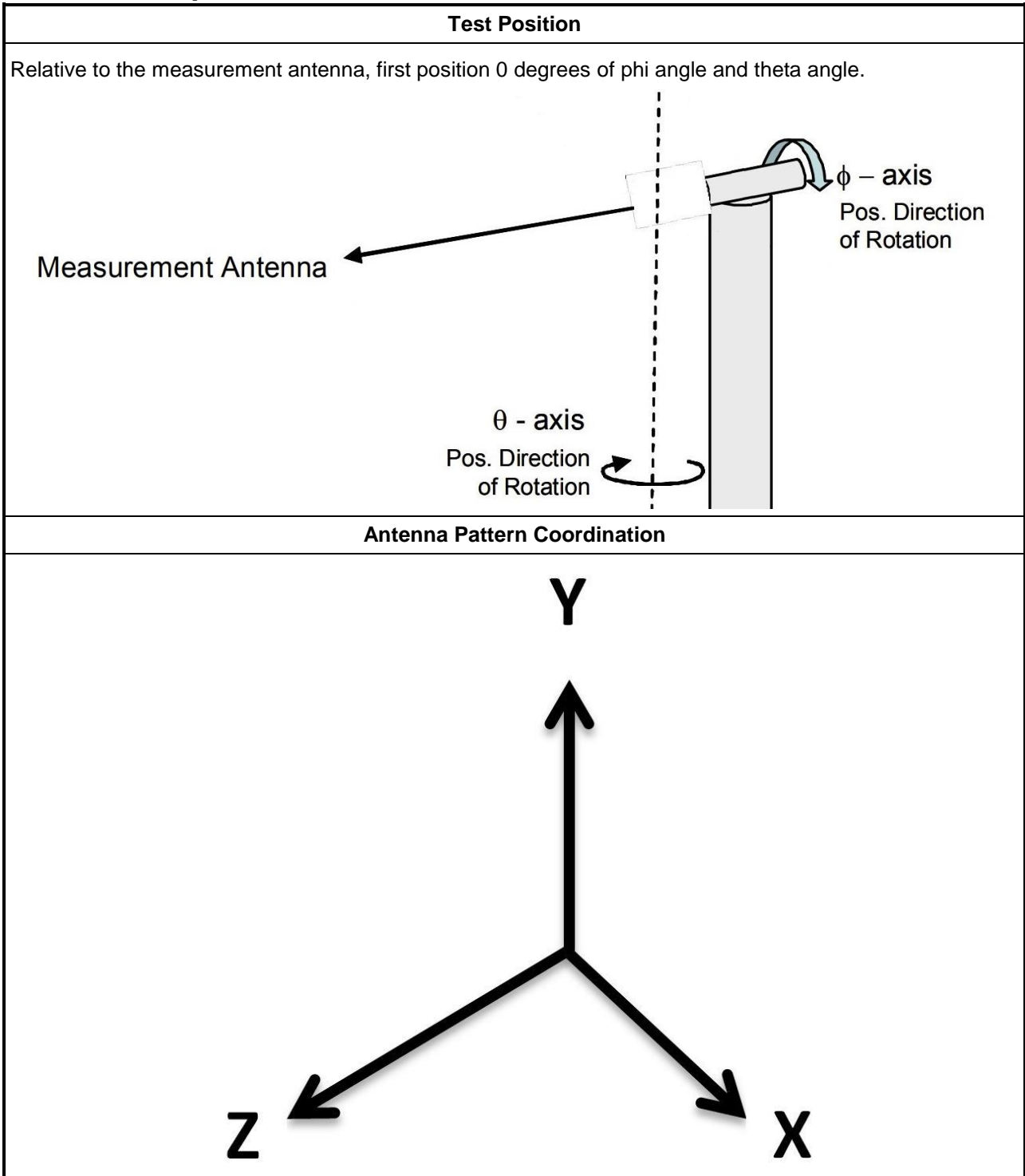
8. Summary of Test Result

Freq(Hz)	2.45G	5.2G	5.3G	5.6G	5.785G
Ant. 1 Max Gain (dBi)	3.86	2.12	2.31	2.76	3.34
Ant. 2 Max Gain (dBi)	3.47	3.81	4.74	3.75	4.12
Ant. 1 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Phi/20/350	Theta/50/240	Theta/50/240	Theta/50/180	Theta/50/180
Ant. 2 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/80/230	Theta/50/130	Theta/50/140	Theta/60/140	Theta/60/140
Max Gain (dBi)	3.86	3.81	4.74	3.75	4.12
DG [1SS] (dBi)	5.85	4.38	4.95	4.04	4.27
DG [2SS] (dBi)	2.85	1.41	2.52	1.21	1.88

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 14

Appendix B – Antenna Pattern.....Page 20

Appendix C – Test Photos..... Page 24

—————THE END—————



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Ant. 2 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/80/230	Theta/50/130	Theta/50/140	Theta/60/140	Theta/60/140
Max Gain (dBi)	3.86	3.81	4.74	3.75	4.12
DG [1SS] (dBi)	5.85	4.38	4.95	4.04	4.27
DG [2SS] (dBi)	2.85	1.41	2.52	1.21	1.88



01071	4.02400	-14.01100	4.11100	-11.88100	4.19800	-11.77400	4.28500	-11.66700	4.37200	-11.55800	4.45900	-11.44900	4.54600	-11.34000	4.63300	-11.23100	4.72000	-11.12200	4.80700	-11.01300	4.89400	-10.90400	4.98100	-10.79500	5.06800	-10.68600	5.15500	-10.57700	5.24200	-10.46800	5.32900	-10.35900	5.41600	-10.25000	5.50300	-10.14100	5.59000	-10.03200	5.67700	-9.92300	5.76400	-9.81400	5.85100	-9.70500	5.93800	-9.59600	6.02500	-9.48700	6.11200	-9.37800	6.19900	-9.26900	6.28600	-9.16000	6.37300	-9.05100	6.46000	-8.94200	6.54700	-8.83300	6.63400	-8.72400	6.72100	-8.61500	6.80800	-8.50600	6.89500	-8.39700	6.98200	-8.28800	7.06900	-8.17900	7.15600	-8.07000	7.24300	-7.96100	7.33000	-7.85200	7.41700	-7.74300	7.50400	-7.63400	7.59100	-7.52500	7.67800	-7.41600	7.76500	-7.30700	7.85200	-7.19800	7.93900	-7.08900	8.02600	-6.98000	8.11300	-6.87100	8.20000	-6.76200	8.28700	-6.65300	8.37400	-6.54400	8.46100	-6.43500	8.54800	-6.32600	8.63500	-6.21700	8.72200	-6.10800	8.80900	-5.99900	8.89600	-5.89000	8.98300	-5.78100	9.07000	-5.67200	9.15700	-5.56300	9.24400	-5.45400	9.33100	-5.34500	9.41800	-5.23600	9.50500	-5.12700	9.59200	-5.01800	9.67900	-4.90900	9.76600	-4.80000	9.85300	-4.69100	9.94000	-4.58200	10.02700	-4.47300	10.11400	-4.36400	10.20100	-4.25500	10.28800	-4.14600	10.37500	-4.03700	10.46200	-3.92800	10.54900	-3.81900	10.63600	-3.71000	10.72300	-3.60100	10.81000	-3.49200	10.89700	-3.38300	10.98400	-3.27400	11.07100	-3.16500	11.15800	-3.05600	11.24500	-2.94700	11.33200	-2.83800	11.41900	-2.72900	11.50600	-2.62000	11.59300	-2.51100	11.68000	-2.40200	11.76700	-2.29300	11.85400	-2.18400	11.94100	-2.07500	12.02800	-1.96600	12.11500	-1.85700	12.20200	-1.74800	12.28900	-1.63900	12.37600	-1.53000	12.46300	-1.42100	12.55000	-1.31200	12.63700	-1.20300	12.72400	-1.09400	12.81100	-0.98500	12.89800	-0.87600	12.98500	-0.76700	13.07200	-0.65800	13.15900	-0.54900	13.24600	-0.44000	13.33300	-0.33100	13.42000	-0.22200	13.50700	-0.11300	13.59400	-0.00400	13.68100	0.08500	13.76800	0.17200	13.85500	0.26300	13.94200	0.35400	14.02900	0.44500	14.11600	0.53600	14.20300	0.62700	14.29000	0.71800	14.37700	0.80900	14.46400	0.90000	14.55100	0.99100	14.63800	1.08200	14.72500	1.17300	14.81200	1.26400	14.90000	1.35500	14.98700	1.44600	15.07400	1.53700	15.16100	1.62800	15.24800	1.71900	15.33500	1.81000	15.42200	1.90100	15.50900	1.99200	15.59600	2.08300	15.68300	2.17400	15.77000	2.26500	15.85700	2.35600	15.94400	2.44700	16.03100	2.53800	16.11800	2.62900	16.20500	2.72000	16.29200	2.81100	16.37900	2.90200	16.46600	2.99300	16.55300	3.08400	16.64000	3.17500	16.72700	3.26600	16.81400	3.35700	16.90100	3.44800	16.98800	3.53900	17.07500	3.63000	17.16200	3.72100	17.24900	3.81200	17.33600	3.90300	17.42300	3.99400	17.51000	4.08500	17.59700	4.17600	17.68400	4.26700	17.77100	4.35800	17.85800	4.44900	17.94500	4.54000	18.03200	4.63100	18.11900	4.72200	18.20600	4.81300	18.29300	4.90400	18.38000	4.99500	18.46700	5.08600	18.55400	5.17700	18.64100	5.26800	18.72800	5.35900	18.81500	5.45000	18.90200	5.54100	18.98900	5.63200	19.07600	5.72300	19.16300	5.81400	19.25000	5.90500	19.33700	5.99600	19.42400	6.08700	19.51100	6.17800	19.59800	6.26900	19.68500	6.36000	19.77200	6.45100	19.85900	6.54200	19.94600	6.63300	20.03300	6.72400	20.12000	6.81500	20.20700	6.90600	20.29400	6.99700	20.38100	7.08800	20.46800	7.17900	20.55500	7.27000	20.64200	7.36100	20.72900	7.45200	20.81600	7.54300	20.90300	7.63400	20.99000	7.72500	21.07700	7.81600	21.16400	7.90700	21.25100	8.00000	21.33800	8.09100	21.42500	8.18200	21.51200	8.27300	21.60000	8.36400	21.68700	8.45500	21.77400	8.54600	21.86100	8.63700	21.94800	8.72800	22.03500	8.81900	22.12200	8.91000	22.20900	9.00100	22.29600	9.09200	22.38300	9.18300	22.47000	9.27400	22.55700	9.36500	22.64400	9.45600	22.73100	9.54700	22.81800	9.63800	22.90500	9.72900	22.99200	9.82000	23.07900	9.91100	23.16600	10.00200	23.25300	10.09300	23.34000	10.18400	23.42700	10.27500	23.51400	10.36600	23.60100	10.45700	23.68800	10.54800	23.77500	10.63900	23.86200	10.73000	23.94900	10.82100	24.03600	10.91200	24.12300	11.00300	24.21000	11.09400	24.29700	11.18500	24.38400	11.27600	24.47100	11.36700	24.55800	11.45800	24.64500	11.54900	24.73200	11.64000	24.81900	11.73100	24.90600	11.82200	24.99300	11.91300	25.08000	12.00400	25.16700	12.09500	25.25400	12.18600	25.34100	12.27700	25.42800	12.36800	25.51500	12.45900	25.60200	12.55000	25.68900	12.64100	25.77600	12.73200	25.86300	12.82300	25.95000	12.91400	26.03700	13.00500	26.12400	13.09600	26.21100	13.18700	26.29800	13.27800	26.38500	13.36900	26.47200	13.46000	26.55900	13.55100	26.64600	13.64200	26.73300	13.73300	26.82000	13.82400	26.90700	13.91500	26.99400	14.00600	27.08100	14.09700	27.16800	14.18800	27.25500	14.27900	27.34200	14.37000	27.42900	14.46100	27.51600	14.55200	27.60300	14.64300	27.69000	14.73400	27.77700	14.82500	27.86400	14.91600	27.95100	15.00700	28.03800	15.09800	28.12500	15.18900	28.21200	15.28000	28.29900	15.37100	28.38600	15.46200	28.47300	15.55300	28.56000	15.64400	28.64700	15.73500	28.73400	15.82600	28.82100	15.91700	28.90800	16.00800	28.99500	16.09900	29.08200	16.19000	29.16900	16.28100	29.25600	16.37200	29.34300	16.46300	29.43000	16.55400	29.51700	16.64500	29.60400	16.73600	29.69100	16.82700	29.77800	16.91800	29.86500	17.00900	29.95200	17.10000	30.03900	17.19100	30.12600	17.28200	30.21300	17.37300	30.30000	17.46400	30.38700	17.55500	30.47400	17.64600	30.56100	17.73700	30.64800	17.82800	30.73500	17.91900	30.82200	18.01000	30.90900	18.10100	30.99600	18.19200	31.08300	18.28300	31.17000	18.37400	31.25700	18.46500	31.34400	18.55600	31.43100	18.64700	31.51800	18.73800	31.60500	18.82900	31.69200	18.92000	31.77900	19.01100	31.86600	19.10200	31.95300	19.19300	32.04000	19.28400	32.12700	19.37500	32.21400	19.46600	32.30100	19.55700	32.38800	19.64800	32.47500	19.73900	32.56200	19.83000	32.64900	19.92100	32.73600	20.01200	32.82300	20.10300	32.91000	20.19400	32.99700	20.28500	33.08400	20.37600	33.17100	20.46700	33.25800	20.55800	33.34500	20.64900	33.43200	20.74000	33.51900	20.83100	33.60600	20.92200	33.69300	21.01300	33.78000	21.10400	33.86700	21.19500	33.95400	21.28600	34.04100	21.37700	34.12800	21.46800	34.21500	21.55900	34.30200	21.65000	34.38900	21.74100	34.47600	21.83200	34.56300	21.92300	34.65000	22.01400	34.73700	22.10500	34.82400	22.19600	34.91100	22.28700	34.99800	22.37800	35.08500	22.46900	35.17200	22.56000	35.25900	22.65100	35.34600	22.74200	35.43300	22.83300	35.52000	22.92400	35.60700	23.01500	35.69400	23.10600	35.78100	23.19700	35.86800	23.28800	35.95500	23.37900	36.04200	23.47000	36.12900	23.56100	36.21600	23.65200	36.30300	23.74300	36.39000	23.83400	36.47700	23.92500	36.56400	24.01600	36.65100	24.10700	36.73800	24.19800	36.82500	24.28900	36.91200	24.38000	37.00000	24.47100	37.08700	24.56200	37.17400	24.65300	37.26100	24.74400	37.34800	24.83500	37.43500	24.92600	37.52200	25.01700	37.60900	25.10800	37.69600	25.19900	37.78300	25.29000	37.87000	25.38100	37.95700	25.47200	38.04400	25.56300	38.13100	25.65400	38.21800	25.74500	38.30500	25.83600	38.39200	25.92700	38.47900	26.01800	38.56600	26.10900	38.65300	26.20000	38.74000	26.29100	38.82700	26.38200	38.91400	26.47300	39.00100	26.56400	39.08800	26.65500	39.17500	26.74600	39.26200	26.83700	39.34900	26.92800	39.43600	27.01900	39.52300	27.11000	39.61000	27.20100	39.69700	27.29200	39.78400	27.38300	39.87100	27.47400	39.95800	27.56500	40.04500	27.65600	40.13200	27.74700	40.21900	27.83800	40.30600	27.92900	40.39300	28.02000	40.48000	28.11100	40.56700	28.20200	40.65400	28.29300	40.74100	28.38400	40.82800	28.47500	40.91500	28.56600	41.00200	28.65700	41.08900	28.74800	41.17600	28.83900	41.26300	28.93000	41.35000	29.02100	41.43700	29.11200	41.52400	29.20300	41.61100	29.29400	41.69800	29.38500	41.78500	29.47600	41.87200	29.56700	41.95900	29.65800	42.04600	29.74900	42.13300	29.84000	42.22000	29.93100	42.30700	30.02200	42.39400	30.11300	42.48100	30.20400	42.56800	30.29500	42.65500	30.38600	42.74200	30.47700	42.82900	30.56800	42.91600	30.65900	43.00300	30.75000	43.09000	30.84100	43.17700	30.93200	43.26400	31.02300	43.35100	31.11400	43.43800	31.20500	43.52500	31.29600	43.61200	31.38700	43.69900	31.47800	43.78600	31.56900	43.87300	31.66000	43.96000	31.75100	44.04700	31.84200	44.13400	31.93300	44.22100	32.02400	44.30800	32.11500	44.39500	32.20600	44.48200	32.29700	44.56900	32.38800	44.65600	32.47900	44.74300	32.57000	44.83000	32.66100	44.91700	32.75200	45.00400	32.84300	45.09100	32.93400	45.17800	33.02500	45.26500	33.11600	45.35200	33.20700	45.43900	33.29800	45.52600	33.38900	45.61300	33.48000	45.70000	33.57100	45.78700	33.6
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Total Gain Data

Table with columns for Frequency (MHz), Azimuth (deg), and Elevation (deg) for various antenna configurations. The table contains multiple sections for different antenna types and frequencies, with data points for gain in dBS.

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

