



Antenna Composite Gain Test Report

Equipment	802.11ax WiFi6E 2+2+2 Access Point
Brand Name	Juniper
Model Name	AP64
Applicant	Juniper Networks, Inc. 1133 Innovation Way, Sunnyvale, CA 94089, USA
Manufacturer	Juniper Networks, Inc. 1133 Innovation Way, Sunnyvale, CA 94089, USA
Sample Received	Sep. 13, 2023
Start Test Date	Oct. 04, 2023
Final Test Date	Oct. 04, 2023



Approved by: Jackson Tsai

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1. Operation Mode and Antenna Information

Antenna Position	Brand Name	Model Name	Ant. Type	Connector	Modes of Operation
Ant1 2G6G	Juniper	0990279010_1	PIFA	I-PEX	Radio 2_2.4G / Radio 1_6G
Ant2 2G5G	Juniper	0990279010_2	PIFA	I-PEX	Radio 0_5G / BT+Zigbee +Thread
Ant3 2G5G	Juniper	0990279010_3	PIFA	I-PEX	Radio 1_2.4G / Radio 0_5G
Ant4 2G6G	Juniper	0990279010_4	PIFA	I-PEX	Radio 1_2.4G / Radio 1_6G
Ant5 2G5G6G	Juniper	0990279010_5	PIFA	I-PEX	Radio 2_2.4G / Radio 2_5G / Radio 2_6G

Note:

For 2.4GHz function:

For IEEE 802.11 b/g/n/VHT/ax mode (2TX/2RX) (Radio 1)

Ant3 2G5G and Ant4 2G6G could transmit/receive simultaneously.

For IEEE 802.11 b/g/n/VHT/ax mode (1TX/1RX) (Radio 2)

Ant1 2G6G or Ant5 2G5G6G could transmit/receive.

For IEEE 802.11 b/g/n/VHT/ax mode (2TX/2RX) (Radio 2)

Ant1 2G6G and Ant5 2G5G6G could transmit/receive simultaneously.

For 5GHz function:

For IEEE 802.11 a/n/ac/ax mode (1TX/1RX) (Radio 2)

Ant5 2G5G6G could transmit/receive.

For IEEE 802.11 a/n/ac/ax mode (2TX/2RX) (Radio 0)

Ant2 2G5G and Ant3 2G5G could transmit/receive simultaneously.

For 6GHz function:

For IEEE 802.11 a/ax mode (2TX/2RX) (Radio 1)

Ant1 2G6G and Ant4 2G6G could transmit/receive simultaneously.

For IEEE 802.11 a/ax mode (1TX/1RX) (Radio 2)

Ant5 2G5G6G could transmit/receive.

For BT function:

For IEEE 802.15.1 Bluetooth mode (1TX/1RX)

Ant2 2G5G could transmit/receive.

For Thread function:

For Thread mode (1TX/1RX)

Ant2 2G5G could transmit/receive.

For Zigbee function:

For Zigbee mode (1TX/1RX)

Ant2 2G5G could transmit/receive.



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
5925-6425	6175
6425-6525	6475
6525-6875	6695
6875-7125	6995

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 (°C / %)	Test Date
Radiated	05CH03-HY	Rex Liao	24.0~24.5°C / 50~55%	04/Oct/2023

Note:

Testing Site Information

Brand Name: TDK

Dimension: 11m*6m*6m

Characteristic: Fully Anechoic Chamber

4. Test Facility and Configuration

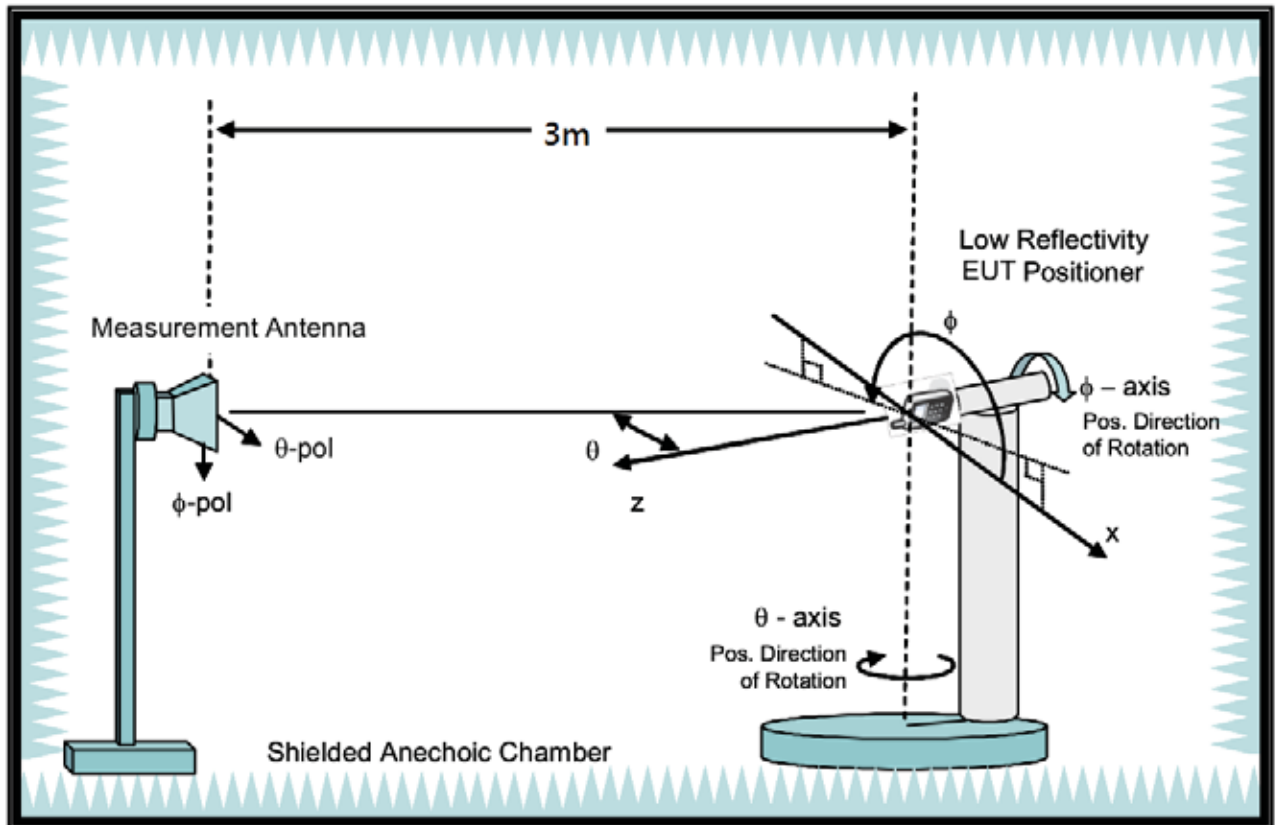
Test configuration: Reference to CITA OTA distributed-axes system configuration.

Chamber: Fully Anechoic Chamber.

Measurement antenna: Dual Polarization Horn antenna

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

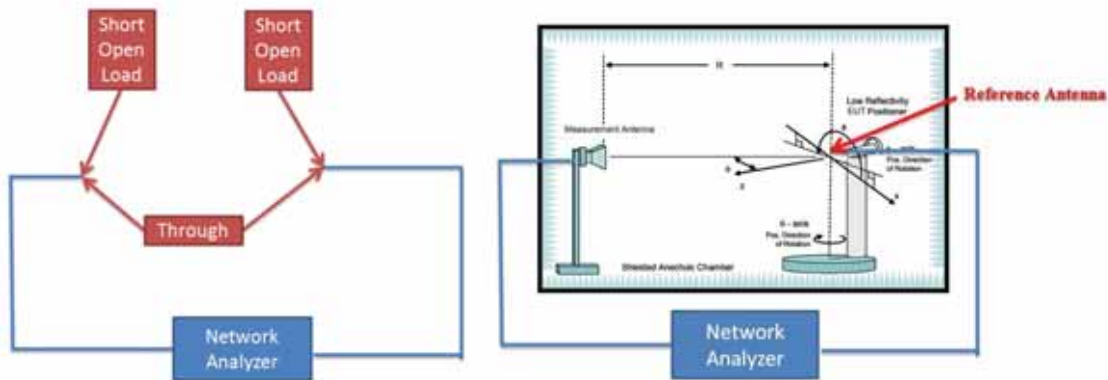
#Reference to CTIA “ctia-test-plan-for-wireless-device-over-the-air-performance-ver-3-7-1”



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)	-33.75	-33.64	-32.91	-32.21	-32.45	-32.33	-32.57	-32.94	-32.78	-33.35	-32.91	-33.81	-34.54	-35.64
G(phi) reading (dB)	-33.19	-32.12	-32.48	-32.51	-32.64	-31.68	-32.24	-32.45	-32.45	-32.85	-32.45	-33.62	-34.48	-35.24
Reference gain (dBi)	10	10.4	10.6	12.3	12.5	13.3	13.3	13.2	13.1	13	13.2	12.4	11.8	11.1
Factor(theta) (dB)	43.75	44.04	43.51	44.51	44.95	45.63	45.87	46.14	45.88	46.35	46.11	46.21	46.34	46.74
Factor(phi) (dB)	43.19	42.52	43.08	44.81	45.14	44.98	45.54	45.65	45.55	45.85	45.65	46.02	46.28	46.34

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

Dual-band mode 2.4G 2Tx Ant.1 & Ant.5

DG_1SS Max Value Position

Frequency (Hz)	2.45G
Ant. 1 (dBi)	1.05
Ant. 5 (dBi)	1.62
DG [1SS] (dBi)	4.35
Polarization	Theta
$\Theta(^{\circ})$	52.5
$\Phi(^{\circ})$	285

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
Ant. 1 [$10^{(G/20)}$]	$10^{(1.05/20)}$
Ant. 5 [$10^{(G/20)}$]	$10^{(1.62/20)}$
Ant. 1 [$10^{(G/20)}$] value	1.128
Ant. 2 [$10^{(G/20)}$] value	1.205
Sum All Antenna [Amax]	2.334
DG [$10 \cdot \log(A_{max}^2/N_{ant})$]	4.35

Note:

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

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



Tri-band mode 2.4G 2Tx Ant.3 & Ant.4

DG_1SS Max Value Position

Frequency (Hz)	2.45G
Ant. 3 (dBi)	-1.14
Ant. 4 (dBi)	4.41
DG [1SS] (dBi)	5.08
Polarization	Theta
$\Theta(^{\circ})$	45
$\Phi(^{\circ})$	352.5

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
Ant. 3 [$10^{(G/20)}$]	$10^{(-1.14/20)}$
Ant. 4 [$10^{(G/20)}$]	$10^{(4.41/20)}$
Ant. 3 [$10^{(G/20)}$] value	0.877
Ant. 4 [$10^{(G/20)}$] value	1.661
Sum All Antenna [Amax]	2.538
DG [$10 \cdot \log(A_{max}^2/N_{ant})$]	5.08

Note:

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

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



Tri-band & Dual-band mode 5G 2Tx Ant.2 & Ant.3

DG_1SS Max Value Position

Frequency (Hz)	5.2G	5.3G	5.6G	5.785G
Ant. 2 (dBi)	4.14	3.93	4.24	0.57
Ant. 3 (dBi)	0.36	0.56	0.34	1.38
DG [1SS] (dBi)	5.46	5.42	5.52	3.99
Polarization	Phi	Phi	Phi	Phi
$\Theta(^{\circ})$	37.5	37.5	45	37.5
$\Phi(^{\circ})$	217.5	217.5	217.5	232.5

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)	5.2G	5.3G	5.6G	5.785G
Ant. 2 [$10^{(G/20)}$]	$10^{(4.14/20)}$	$10^{(3.93/20)}$	$10^{(4.24/20)}$	$10^{(0.57/20)}$
Ant. 3 [$10^{(G/20)}$]	$10^{(0.36/20)}$	$10^{(0.56/20)}$	$10^{(0.34/20)}$	$10^{(1.38/20)}$
Ant. 2 [$10^{(G/20)}$] value	1.611	1.572	1.629	1.068
Ant. 3 [$10^{(G/20)}$] value	1.042	1.067	1.04	1.172
Sum All Antenna [Amax]	2.653	2.639	2.669	2.24
DG [$10 \cdot \log(A_{max}^2/N_{ant})$]	5.46	5.42	5.52	3.99

Note:

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

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



Tri-band mode 6G 2Tx Ant.1 & Ant.4

DG_1SS Max Value Position

Frequency (Hz)	6.175G	6.475G	6.695G	6.995G
Ant. 1 (dBi)	4.45	2.94	1.98	4.32
Ant. 4 (dBi)	-0.39	0.27	0.67	-2.33
DG [1SS] (dBi)	5.37	4.72	4.36	4.63
Polarization	Theta	Theta	Theta	Theta
$\Theta(^{\circ})$	67.5	60	52.5	52.5
$\Phi(^{\circ})$	337.5	337.5	337.5	0

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)	6.175G	6.475G	6.695G	6.995G
Ant. 1 [$10^{(G/20)}$]	$10^{(4.45/20)}$	$10^{(2.94/20)}$	$10^{(1.98/20)}$	$10^{(4.32/20)}$
Ant. 4 [$10^{(G/20)}$]	$10^{(-0.39/20)}$	$10^{(0.27/20)}$	$10^{(0.67/20)}$	$10^{(-2.33/20)}$
Ant. 1 [$10^{(G/20)}$] value	1.669	1.403	1.256	1.644
Ant. 4 [$10^{(G/20)}$] value	0.956	1.032	1.08	0.765
Sum All Antenna [Amax]	2.625	2.434	2.336	2.409
DG [$10 \cdot \log(A_{max}^2/N_{ant})$]	5.37	4.72	4.36	4.63

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
Ant. 1 Max Gain (dBi)	1.58
Ant. 2 Max Gain (dBi)	1.22
Ant. 3 Max Gain (dBi)	1.38
Ant. 4 Max Gain (dBi)	4.41
Ant. 5 Max Gain (dBi)	2.3
Ant. 1 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/52.5/180
Ant. 2 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/52.5/172.5
Ant. 3 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/52.5/90
Ant. 4 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/45/352.5
Ant. 5 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/52.5/307.5
Max Gain (dBi)	4.41
Dual-band mode 2.4G 2Tx DG [1SS] (dBi) Ant.1 & Ant.5	4.35
Tri-band mode 2.4G 2Tx DG [1SS] (dBi) Ant.3 & Ant.4	5.08

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.

Freq(Hz)	5.2G	5.3G	5.6G	5.785G
Ant. 2 Max Gain (dBi)	4.71	4.7	5.46	3.57
Ant. 3 Max Gain (dBi)	5.41	5.38	4.54	2.8
Ant. 5 Max Gain (dBi)	3.96	4.26	3.43	2.52
Ant. 2 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/37.5/307.5	Theta/37.5/300	Theta/30/292.5	Theta/30/285
Ant. 3 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/37.5/135	Theta/30/142.5	Theta/22.5/142.5	Theta/37.5/135
Ant. 5 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Phi/7.5/135	Theta/52.5/82.5	Theta/22.5/22.5	Theta/52.5/352.5
Max Gain (dBi)	5.41	5.38	5.46	3.57
Tri-band & Dual-band mode 5G 2Tx DG [1SS] (dBi) Ant.2 & Ant.3	5.46	5.42	5.52	3.99

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.

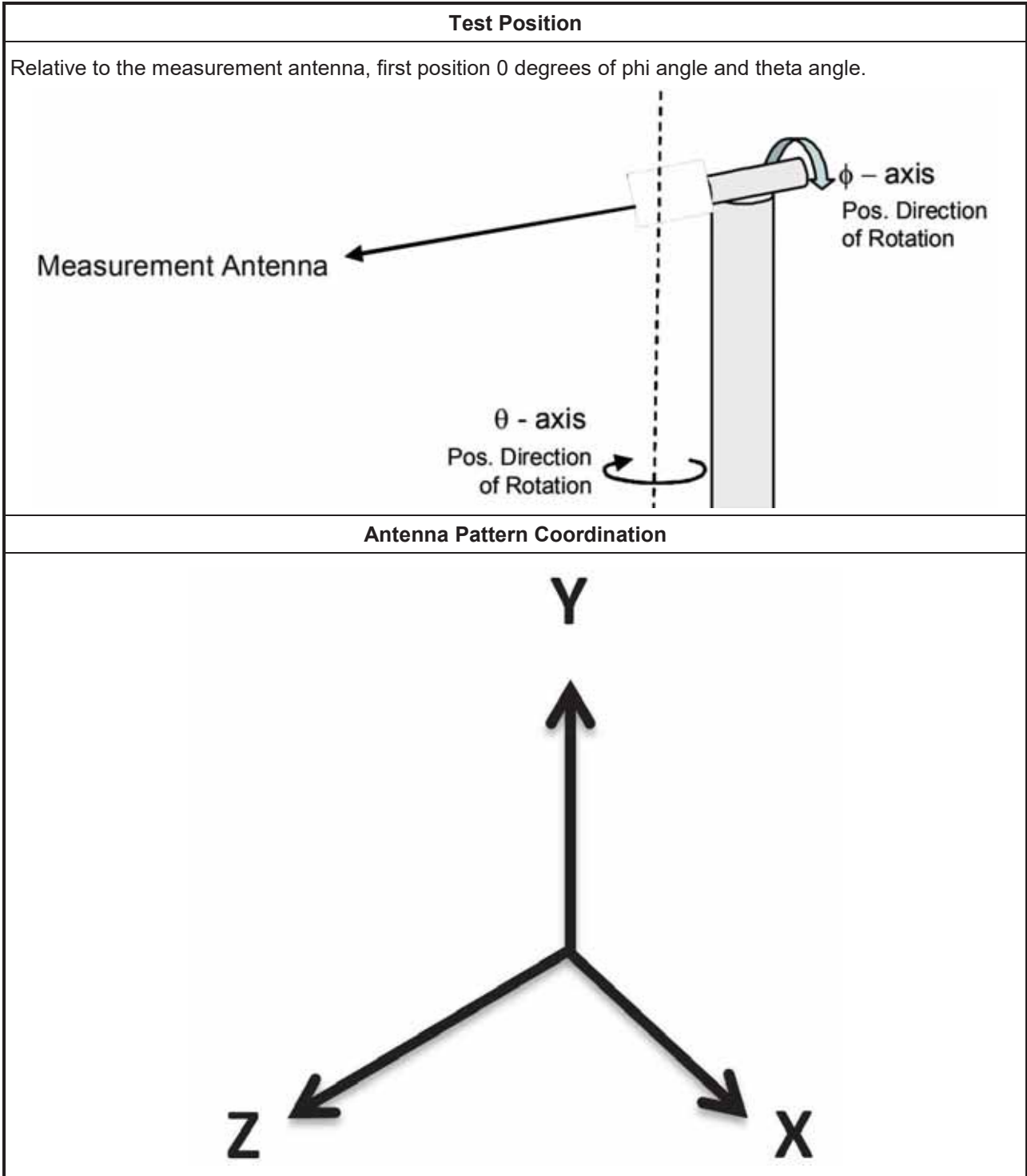


Freq(Hz)	6.175G	6.475G	6.695G	6.995G
Ant. 1 Max Gain (dBi)	4.45	3.93	3.66	4.32
Ant. 4 Max Gain (dBi)	3.05	2.9	4.25	3.33
Ant. 5 Max Gain (dBi)	2.77	3.9	3.25	3.56
Ant. 1 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/67.5/337.5	Theta/52.5/112.5	Theta/52.5/352.5	Theta/52.5/0
Ant. 4 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/67.5/172.5	Theta/52.5/210	Theta/60/217.5	Theta/60/210
Ant. 5 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/52.5/112.5	Theta/67.5/307.5	Theta/75/300	Theta/37.5/135
Max Gain (dBi)	4.45	3.93	4.25	4.32
Tri-band mode 6G 2Tx DG [1SS] (dBi) Ant.1 & Ant.4	5.37	4.72	4.36	4.63

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-1543	1GHz~18GHz	May 11, 2023	May 10, 2024
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	Jul. 28, 2023	Jul. 27, 2024
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.

Appendix A – Radiated Composite Gain.....Page 18
Appendix B – Antenna Pattern.....Page 38
Appendix C – Test Photos..... Page 48

————THE END————



Radiated Composite Gain Data

Appendix A

Freq(Hz)	2.45G	5.2G	5.3G	5.6G	5.785G	6.175G	6.475G	6.695G	6.995G
Ant. 1 Max Gain (dBi)	1.58					4.45	3.93	3.66	4.32
Ant. 2 Max Gain (dBi)	1.22	4.71	4.7	5.46	3.57				
Ant. 3 Max Gain (dBi)	1.38	5.41	5.38	4.54	2.8				
Ant. 4 Max Gain (dBi)	4.41					3.05	2.9	4.25	3.33
Ant. 5 Max Gain (dBi)	2.3	3.96	4.26	3.43	2.52	2.77	3.9	3.25	3.56
Ant. 1 Polarization/Θ(°)/Φ(°)	Theta/52.5/180					Theta/67.5/337.5	Theta/52.5/112.5	Theta/52.5/352.5	Theta/52.5/0
Ant. 2 Polarization/Θ(°)/Φ(°)	Theta/52.5/172.5	Theta/37.5/307.5	Theta/37.5/300	Theta/30/292.5	Theta/30/285				
Ant. 3 Polarization/Θ(°)/Φ(°)	Theta/52.5/90	Theta/37.5/135	Theta/30/142.5	Theta/22.5/142.5	Theta/37.5/135				
Ant. 4 Polarization/Θ(°)/Φ(°)	Theta/45/352.5					Theta/67.5/172.5	Theta/52.5/210	Theta/60/217.5	Theta/60/210
Ant. 5 Polarization/Θ(°)/Φ(°)	Theta/52.5/307.5	Phi/7.5/135	Theta/52.5/82.5	Theta/22.5/22.5	Theta/52.5/352.5	Theta/52.5/112.5	Theta/67.5/307.5	Theta/75/300	Theta/37.5/135
Max Gain (dBi)	4.41	5.41	5.38	5.46	3.57	4.45	3.93	4.25	4.32
Dual-band mode 2.4G 2Tx DG [1SS] (dBi) Ant.1 & Ant.5	4.35								
Tri-band mode 2.4G 2Tx DG [1SS] (dBi) Ant.3 & Ant.4	5.08								
Tri-band & Dual-band mode 5G 2Tx DG [1SS] (dBi) Ant.2 & Ant.3		5.46	5.42	5.52	3.99				
Tri-band mode 6G 2Tx DG [1SS] (dBi) Ant.1 & Ant.4						5.37	4.72	4.36	4.63



Radiated Composite Gain Data

Appendix A

(01507)	-13.71-13.77	-12.35-10.01	-7.63-5.89	-4.71-4.01	-3.77-3.36	-4.47-5.09	-5.51-5.78	-6.05-6.47	-6.84-8.82	-6.55-6.09	-5.42-4.71	-4.25-4.21	-4.61-5.14	-5.51-6.61	-4.41-6	-4.98-3.78	-3.34-3.33	-3.45-3.3	-3.88-4.25	-4.72-5.33	-5.93-6.47	-6.54-7.55	-6.83-10.15	-11.81-13.1
(0157)	-7.97-7.4	-6.55-6.59	-4.55-3.82	-2.87-2.26	-1.9-1.7	-1.71-1.83	-1.85-2.1	-2.42-2.94	-3.47-3.81	-3.82-3.33	-3.14-2.76	-2.57-2.59	-2.85-3.21	-3.54-3.79	-3.9-4	-3.98-3.86	-3.78-3.81	-4.05-4.25	-4.44-4.47	-4.86-5.06	-5.08-5.39	-5.38-5.46	-5.88-6.64	-7.58-8.63
(0162)	-8.13-7.45	-6.59-6.53	-4.61-5.64	-3.59-4.54	-2.69-2.84	-4.53-6.48	-5.79-6.84	-3.71-3.73	-5.15-5.25	-5.95-6.19	-6.56-5.25	-5.53-6.53	-6.82-7.35	-8.17-8.29	-7.97-8.29	-8.56-8.71	-8.89-8.99	-9.17-9.27	-9.58-9.68	-10.43-12	-11.71-12.7	-12.61-13.7	-13.73-15.8	-15.88-16.3
(0168)	-14.16-13.48	-13.11-11.77	-13.98-13.72	-14.61-13.96	-12.5-11.97	-10.88-10.22	-9.31-9.39	-8.59-9.87	-10.3-10.98	-11.69-11.97	-12.19-12.88	-12.75-12.81	-13.46-14.27	-15.03-15.14	-15.31-15.87	-15.25-15.96	-14.68-14.28	-13.63-12.74	-12.31-12.47	-12.38-12.15	-11.98-12.09	-12.61-12.27	-12.13-12.27	-12.85-13.52

Tri-band & Dual-band mode 5G 2Tx Ant.2 & Ant.3

Freq(M)	5.5G Ant. 2	5.5G Ant. 3	5.5G Ant. 2	5.5G Ant. 3	5.5G Ant. 2	5.5G Ant. 3	5.5G Ant. 2	5.5G Ant. 3	5.5G Ant. 2	5.5G Ant. 3	5.5G Ant. 2	5.5G Ant. 3	5.5G Ant. 2	5.5G Ant. 3	5.5G Ant. 2	5.5G Ant. 3	5.5G Ant. 2	5.5G Ant. 3	5.5G Ant. 2	5.5G Ant. 3	5.5G Ant. 2	5.5G Ant. 3	5.5G Ant. 2	5.5G Ant. 3
(01507)	-13.71-13.77	-12.35-10.01	-7.63-5.89	-4.71-4.01	-3.77-3.36	-4.47-5.09	-5.51-5.78	-6.05-6.47	-6.84-8.82	-6.55-6.09	-5.42-4.71	-4.25-4.21	-4.61-5.14	-5.51-6.61	-4.41-6	-4.98-3.78	-3.34-3.33	-3.45-3.3	-3.88-4.25	-4.72-5.33	-5.93-6.47	-6.54-7.55	-6.83-10.15	-11.81-13.1
(0157)	-7.97-7.4	-6.55-6.59	-4.55-3.82	-2.87-2.26	-1.9-1.7	-1.71-1.83	-1.85-2.1	-2.42-2.94	-3.47-3.81	-3.82-3.33	-3.14-2.76	-2.57-2.59	-2.85-3.21	-3.54-3.79	-3.9-4	-3.98-3.86	-3.78-3.81	-4.05-4.25	-4.44-4.47	-4.86-5.06	-5.08-5.39	-5.38-5.46	-5.88-6.64	-7.58-8.63
(0162)	-8.13-7.45	-6.59-6.53	-4.61-5.64	-3.59-4.54	-2.69-2.84	-4.53-6.48	-5.79-6.84	-3.71-3.73	-5.15-5.25	-5.95-6.19	-6.56-5.25	-5.53-6.53	-6.82-7.35	-8.17-8.29	-7.97-8.29	-8.56-8.71	-8.89-8.99	-9.17-9.27	-9.58-9.68	-10.43-12	-11.71-12.7	-12.61-13.7	-13.73-15.8	-15.88-16.3
(0168)	-14.16-13.48	-13.11-11.77	-13.98-13.72	-14.61-13.96	-12.5-11.97	-10.88-10.22	-9.31-9.39	-8.59-9.87	-10.3-10.98	-11.69-11.97	-12.19-12.88	-12.75-12.81	-13.46-14.27	-15.03-15.14	-15.31-15.87	-15.25-15.96	-14.68-14.28	-13.63-12.74	-12.31-12.47	-12.38-12.15	-11.98-12.09	-12.61-12.27	-12.13-12.27	-12.85-13.52



Radiated Composite Gain Data

Appendix A

Table with columns for frequency ranges (e.g., (15127) 11.41-11.05) and gain values. The table is organized into sections with headers like 'FreqID', 'Theta', and 'DGain'.



Radiated Composite Gain Data

Appendix A

Table with columns for frequency (MHz), gain values, and various identifiers (e.g., 2(25), 3(25), 4(25), etc.). It contains a large amount of numerical data organized in a grid format.



Antenna Pattern

Appendix B

Table with columns for Azimuth (°), Elevation (°), and Gain (dBS) for various antenna configurations. The table contains multiple rows of data for different antenna models and configurations.



Antenna Pattern

Appendix B

Phi (°)	2.512-15	1.716-12	1.641-8	1.641-8	2.272-61	2.702-53	2.342-15	2.152-28	2.893-37	3.983-52	3.192-67	2.332-59	1.731-33	0.783-30	-0.694-41	-0.771-18	-1.424-148	-1.271-120	-0.652-29	1.292-63	2.592-88	2.782-51	2.242-26	2.372-56	
(H) (2.5)	1.831-22	0.840-25	-0.193-35	0.151-22	2.082-34	2.131-65	1.391-38	1.301-87	2.710-14	3.343-07	2.491-88	1.561-50	1.193-63	0.093-31	-0.411-68	0.130-45	0.370-30	1.351-92	-1.581-70	0.121-07	1.691-92	1.971-97	1.671-35	1.411-85	
(H) (2.0)	1.330-35	-0.962-24	-3.701-355	-1.820-09	0.919-33	1.501-61	1.781-76	2.611-40	2.610-64	0.860-11	1.310-28	0.610-43	0.610-43	0.520-26	-0.611-48	0.310-45	0.500-69	0.340-68	-0.860-06	0.910-21	0.591-26	0.210-24	1.621-35	1.211-35	
(H) (1.5)	1.790-46	-1.592-21	-6.024-36	-2.097-04	0.010-12	1.062-44	2.921-38	1.501-45	2.363-46	3.741-98	0.740-06	-0.642-29	0.370-62	0.460-04	-1.141-71	-0.291-09	1.970-95	0.330-18	-0.431-19	0.401-81	2.620-84	2.411-28	0.831-73	2.372-05	
(H) (1.0)	2.201-15	-0.781-57	-3.361-284	-1.790-34	-0.260-10	0.680-22	3.251-76	3.040-47	1.952-85	2.371-58	0.450-58	-0.676-10	0.362-13	-0.103-11	-0.251-36	-0.160-39	1.550-16	0.461-05	-0.349-19	0.051-29	2.915-33	2.102-82	1.932-42	2.822-64	
(H) (0.5)	2.251-24	-0.711-87	-2.761-285	-2.241-26	-0.211-19	0.842-33	2.621-11	-1.451-17	0.391-86	1.831-43	0.980-46	-0.511-94	-1.070-37	0.050-71	-2.360-75	-4.132-244	-1.421-189	-1.252-126	-0.281-32	0.081-38	2.431-69	1.932-54	2.732-73	2.732-73	
(H) (0.2)	1.010-21	-1.812-26	2.731-40	2.341-23	-0.333-19	-0.240-67	0.430-85	2.611-82	0.540-48	0.280-36	0.041-41	-2.071-258	3.130-133	-1.580-143	-0.730-143	-2.241-43	-2.770-226	-2.214-63	-0.590-206	0.211-41	1.491-36	1.960-13	1.841-38	1.731-66	
(H) (0.1)	0.471-10	3.221-85	-3.381-93	0.411-98	-0.831-261	-1.571-177	-2.311-275	3.841-126	-1.711-184	-1.371-311	0.621-37	3.131-391	4.441-386	-2.421-266	-4.318-69	-8.782-326	-4.932-230	-2.233-430	0.822-256	0.401-33	0.520-82	2.450-271	0.750-59	0.590-02	
(H) (0.05)	2.610-35	5.761-49	-4.571-97	4.571-97	-0.441-36	-3.291-44	4.961-65	5.131-29	1.071-384	-3.951-257	-1.502-89	-5.521-557	-0.280-80	-2.742-45	-6.299-522	-11.249-330	5.441-271	3.114-386	-0.280-38	0.441-37	0.070-27	0.251-27	2.472-310	2.742-310	
(H) (0.02)	4.991-468	8.171-87	0.917-70	1.789-85	-0.930-58	5.247-04	8.071-62	7.086-55	-4.946-06	6.034-86	-3.714-425	-7.057-174	-8.859-811	-8.441-78	-7.736-322	-12.462-232	-7.866-522	-5.064-45	-0.292-87	-1.644-05	0.219-529	-0.838-84	-5.856-52	-7.024-26	
(H) (0.01)	2.541-82	0.881-19	0.001-10	0.971-28	0.591-27	0.541-27	0.541-27	0.541-27	0.541-27	0.541-27	0.541-27	0.541-27	0.541-27	0.541-27	0.541-27	0.541-27	0.541-27	0.541-27	0.541-27	0.541-27	0.541-27	0.541-27	0.541-27	0.541-27	
(H) (0.005)	1.271-23	-1.581-105	-1.281-112	-0.010-14	-1.162-120	-0.401-197	-1.231-127	-1.341-109	0.431-167	-1.059-98	-0.959-171	-1.623-146	-1.339-1294	-1.930-147	-1.661-147	-1.541-153	-1.527-151	-1.462-107	-1.579-154	-1.581-152	-1.319-144	-1.524-116	-1.599-128	-1.538-113	-1.538-113
(H) (0.002)	1.034-120	-1.341-112	-1.250-120	-1.136-116	-1.156-135	-1.330-148	-1.560-167	-1.468-122	-1.117-112	-1.321-148	-1.259-150	-1.435-151	-1.623-142	-1.423-143	-1.467-143	-1.520-128	-1.420-155	-1.539-138	-1.511-142	-1.481-142	-1.481-142	-1.511-142	-1.538-116	-1.538-116	-1.538-116
(H) (0.001)	1.034-120	-1.341-112	-1.250-120	-1.136-116	-1.156-135	-1.330-148	-1.560-167	-1.468-122	-1.117-112	-1.321-148	-1.259-150	-1.435-151	-1.623-142	-1.423-143	-1.467-143	-1.520-128	-1.420-155	-1.539-138	-1.511-142	-1.481-142	-1.481-142	-1.511-142	-1.538-116	-1.538-116	-1.538-116
(H) (0.0005)	1.034-120	-1.341-112	-1.250-120	-1.136-116	-1.156-135	-1.330-148	-1.560-167	-1.468-122	-1.117-112	-1.321-148	-1.259-150	-1.435-151	-1.623-142	-1.423-143	-1.467-143	-1.520-128	-1.420-155	-1.539-138	-1.511-142	-1.481-142	-1.481-142	-1.511-142	-1.538-116	-1.538-116	-1.538-116
(H) (0.0002)	1.034-120	-1.341-112	-1.250-120	-1.136-116	-1.156-135	-1.330-148	-1.560-167	-1.468-122	-1.117-112	-1.321-148	-1.259-150	-1.435-151	-1.623-142	-1.423-143	-1.467-143	-1.520-128	-1.420-155	-1.539-138	-1.511-142	-1.481-142	-1.481-142	-1.511-142	-1.538-116	-1.538-116	-1.538-116
(H) (0.0001)	1.034-120	-1.341-112	-1.250-120	-1.136-116	-1.156-135	-1.330-148	-1.560-167	-1.468-122	-1.117-112	-1.321-148	-1.259-150	-1.435-151	-1.623-142	-1.423-143	-1.467-143	-1.520-128	-1.420-155	-1.539-138	-1.511-142	-1.481-142	-1.481-142	-1.511-142	-1.538-116	-1.538-116	-1.538-116
(H) (0.00005)	1.034-120	-1.341-112	-1.250-120	-1.136-116	-1.156-135	-1.330-148	-1.560-167	-1.468-122	-1.117-112	-1.321-148	-1.259-150	-1.435-151	-1.623-142	-1.423-143	-1.467-143	-1.520-128	-1.420-155	-1.539-138	-1.511-142	-1.481-142	-1.481-142	-1.511-142	-1.538-116	-1.538-116	-1.538-116
(H) (0.00002)	1.034-120	-1.341-112	-1.250-120	-1.136-116	-1.156-135	-1.330-148	-1.560-167	-1.468-122	-1.117-112	-1.321-148	-1.259-150	-1.435-151	-1.623-142	-1.423-143	-1.467-143	-1.520-128	-1.420-155	-1.539-138	-1.511-142	-1.481-142	-1.481-142	-1.511-142	-1.538-116	-1.538-116	-1.538-116
(H) (0.00001)	1.034-120	-1.341-112	-1.250-120	-1.136-116	-1.156-135	-1.330-148	-1.560-167	-1.468-122	-1.117-112	-1.321-148	-1.259-150	-1.435-151	-1.623-142	-1.423-143	-1.467-143	-1.520-128	-1.420-155	-1.539-138	-1.511-142	-1.481-142	-1.481-142	-1.511-142	-1.538-116	-1.538-116	-1.538-116

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

