



Antenna Composite Gain Test Report

Equipment	5400 Mbps 11ax Wi-Fi Mesh Extender Wi-Fi 6 Smart Mesh System 5400 Mbps 11ax Wi-Fi Mesh Access Point AX5400 Wi-Fi 6 Router Home Wi-Fi Solution Kit WiFi 6 Booster Wi-Fi 6 Smart Mesh Extender
Brand Name	Airties
Model Name	Air 4960X, Air 4960XR
Applicant	Airties Wireless Networks Sehit Mehmet Mikdat Uluunlu Sokagi No:23 Esentepe, Sisli İstanbul, 34394 Turkey
Manufacturer	Airties Wireless Networks Sehit Mehmet Mikdat Uluunlu Sokagi No:23 Esentepe, Sisli İstanbul, 34394 Turkey
Sample Received	Mar. 10, 2022
Start Test Date	Mar. 30, 2022
Final Test Date	Mar. 30, 2022
SW version	4.130.1.0.1755_wltest
HW version	4960X-D01-M01-R08
Serial Number	AG2932203000004



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History of this test report

Report No.	Version	Description	Issued Date
AP230923AA	01	Initial issue of report	Jun. 07, 2022



1. Operation Mode and Antenna Information

Antenna Position	RF Port		Brand Name	Model Name	Ant. Type	Connector	Modes of Operation
	2.4GHz	5GHz					
2G 5GAnt1	2	1	AirTies	A01	Printed	N/A	2.4GHz, 5GHz UNII 1~3
2G 5GAnt2	1	4	AirTies	A30	Printed	N/A	2.4GHz, 5GHz UNII 1~3
5GAnt3	-	2	AirTies	A1X	Printed	N/A	5GHz UNII 1~3
5GAnt4	-	3	AirTies	A2X	Printed	N/A	5GHz UNII 1~3

Note:

2.4GHz Operation Mode (2TX/2RX)

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

2G 5GAnt1~2G 5GAnt2 could transmit/receive simultaneously.

5GHz Operation Mode (4TX/4RX)

2G 5GAnt1~5GAnt 4 can be used as transmitting/receiving antenna.

2G 5GAnt1~5GAnt 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		
<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. 30, 2022

Note:

Testing Site Information

Brand Name: TDK

Dimension: 11m*6m*6m

Characteristic: Fully Anechoic Chamber

4. Test Facility and Configuration

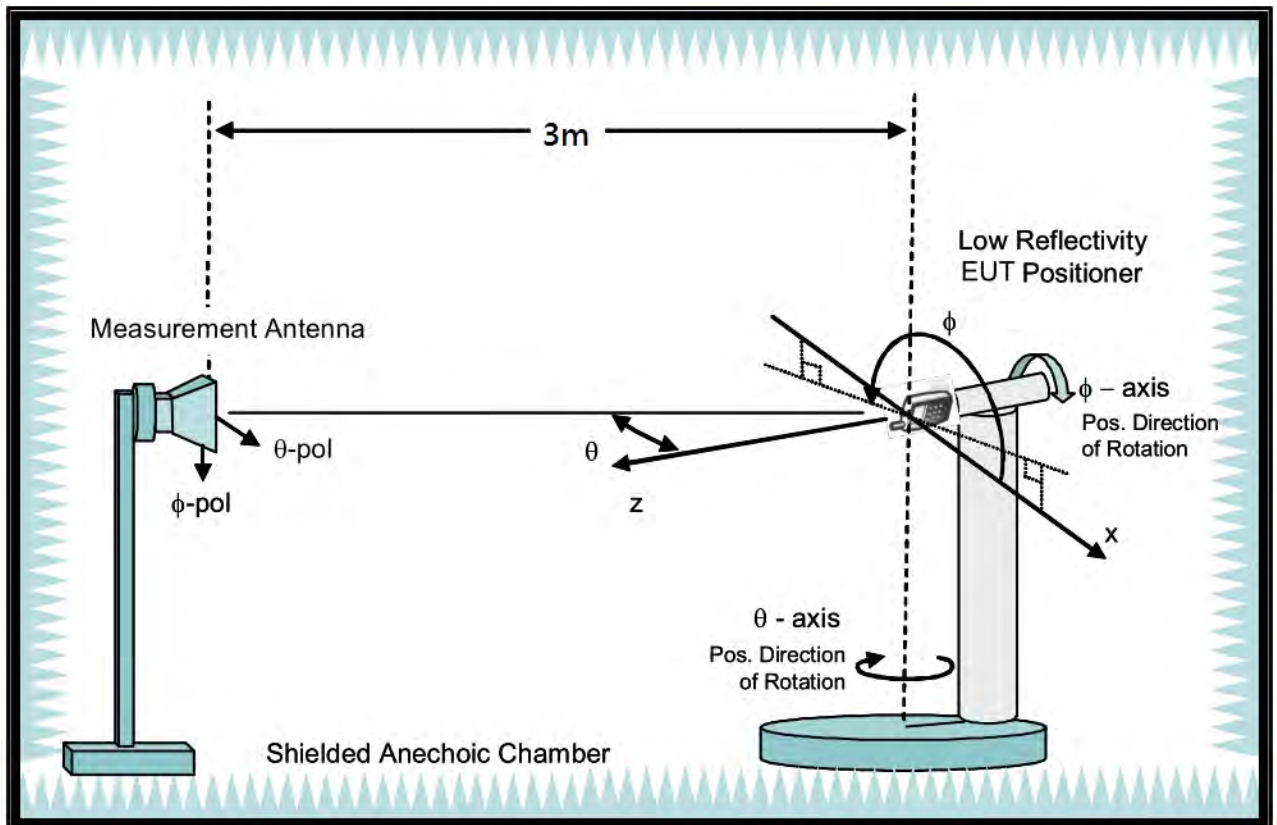
Test configuration: Reference to CITA OTA distributed-axes system configuration.

Chamber: Fully Anechoic Chamber.

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

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

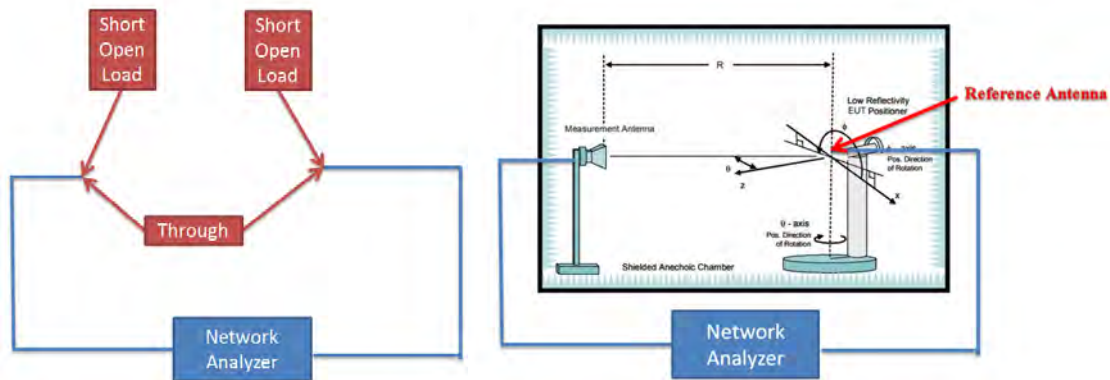
#Reference to CTIA “ctia-test-plan-for-wireless-device-over-the-air-performance-ver-3-7-1”



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 S21 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 S21 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
S21 values (dBi)	-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)	41.63	41.81	41.89	43.72	43.78	44.12	43.5	43.78	43.76	43.88	44.45	45.14	46.08	46.51



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 S21 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.



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)	-1.69	-2.37	-3.28	2.98	-3.64
Ant. 2 (dBi)	1.31	-1.07	-1.03	-6.92	-0.68
Ant. 3 (dBi)	-	1.14	2.05	-0.51	1.02
Ant. 4 (dBi)	-	0.6	1.09	-0.97	2.7
DG [1SS] (dBi)	2.95	5.7	5.96	5.34	6.17
Polarization	Theta	Theta	Theta	Phi	Theta
Θ (°)	110	10	100	20	110
Φ (°)	30	90	270	10	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)	2.45G	5.2G	5.3G	5.6G	5.785G
Ant. 1 [$10^{(G/20)}$]	$10^{(-1.69/20)}$	$10^{(-2.37/20)}$	$10^{(-3.28/20)}$	$10^{(2.98/20)}$	$10^{(-3.64/20)}$
Ant. 2 [$10^{(G/20)}$]	$10^{(1.31/20)}$	$10^{(-1.07/20)}$	$10^{(-1.03/20)}$	$10^{(-6.92/20)}$	$10^{(-0.68/20)}$
Ant. 3 [$10^{(G/20)}$]	-	$10^{(1.14/20)}$	$10^{(2.05/20)}$	$10^{(-0.51/20)}$	$10^{(1.02/20)}$
Ant. 4 [$10^{(G/20)}$]	-	$10^{(0.6/20)}$	$10^{(1.09/20)}$	$10^{(-0.97/20)}$	$10^{(2.7/20)}$
Ant. 1 [$10^{(G/20)}$] value	0.823	0.761	0.685	1.409	0.658
Ant. 2 [$10^{(G/20)}$] value	1.163	0.884	0.888	0.451	0.925
Ant. 3 [$10^{(G/20)}$] value	-	1.14	1.266	0.943	1.125
Ant. 4 [$10^{(G/20)}$] value	-	1.072	1.134	0.894	1.365
Sum All Antenna [Amax]	1.986	3.857	3.974	3.697	4.072
DG [$10 \cdot \log(A_{max}^2/N_{ant})$]	2.95	5.7	5.96	5.34	6.17

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



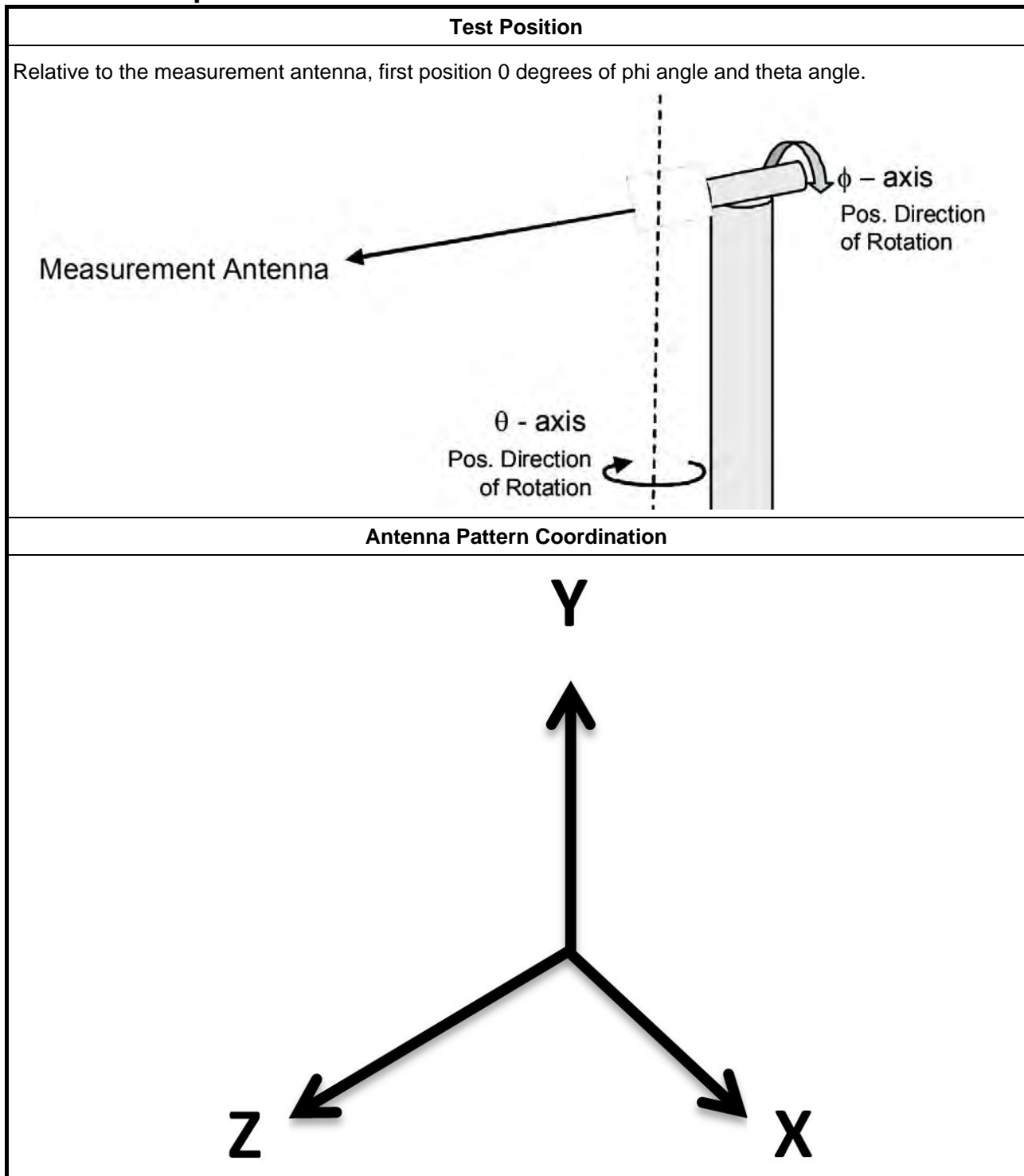
8. Summary of Test Result

Frequency (Hz)	2.45G	5.2G	5.3G	5.6G	5.785G
Ant. 1 Max Gain (dBi)	2.73	3.56	3.95	4.61	4.2
Ant. 2 Max Gain (dBi)	1.86	2.24	1.7	3.3	3.16
Ant. 3 Max Gain (dBi)	-	1.89	2.05	1.17	1.02
Ant. 4 Max Gain (dBi)	-	1.89	1.14	2.73	3.97
Ant. 1 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/70/80	Phi/150/0	Theta/140/270	Theta/140/270	Theta/140/270
Ant. 2 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/120/30	Theta/90/90	Theta/110/130	Theta/120/60	Theta/120/60
Ant. 3 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	-	Theta/20/90	Theta/100/270	Theta/20/90	Theta/110/270
Ant. 4 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	-	Theta/120/200	Theta/120/200	Theta/120/200	Theta/90/290
Max Gain (dBi)	2.73	3.56	3.95	4.61	4.2
DG [1SS] (dBi)	2.95	5.7	5.96	5.34	6.17
DG [2SS] (dBi)	2.73	3.56	3.95	4.61	4.2
DG [4SS] (dBi)	-	3.56	3.95	4.61	4.2

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.
4. Directional Gain (4SS) = Directional Gain (1SS) – 6dB. 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.

Appendix A – Radiated Composite Gain of 2.4GHz and 5GHz.....	Page 13
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Appendix C –Test Photos.....	Page 28



Freq(Hz)	2.45G	5.2G	5.3G	5.6G	5.785G
Ant. 1 Max Gain (dBi)	2.73	3.56	3.95	4.61	4.2
Ant. 2 Max Gain (dBi)	1.86	2.24	1.7	3.3	3.16
Ant. 3 Max Gain (dBi)		1.89	2.05	1.17	1.02
Ant. 4 Max Gain (dBi)		1.89	1.14	2.73	3.97
Ant. 1 Polarization/ $\theta(^{\circ})/\phi(^{\circ})$	Theta/70/80	Phi/150/0	Theta/140/270	Theta/140/270	Theta/140/270
Ant. 2 Polarization/ $\theta(^{\circ})/\phi(^{\circ})$	Theta/120/30	Theta/90/90	Theta/110/130	Theta/120/60	Theta/120/60
Ant. 3 Polarization/ $\theta(^{\circ})/\phi(^{\circ})$		Theta/20/90	Theta/100/270	Theta/20/90	Theta/110/270
Ant. 4 Polarization/ $\theta(^{\circ})/\phi(^{\circ})$		Theta/120/200	Theta/120/200	Theta/120/200	Theta/90/290
Max Gain (dBi)	2.73	3.56	3.95	4.61	4.2
DG [1SS] (dBi)	2.95	5.7	5.96	5.34	6.17
DG [2SS] (dBi)	2.73	3.56	3.95	4.61	4.2
DG [4SS] (dBi)		3.56	3.95	4.61	4.2



Radiated Composite Gain of 2.4GHz and 5GHz

Appendix A

Table with columns for frequency (MHz) and gain values. The table is organized into sections labeled 'Table 1', 'Table 2', and 'Table 3', each containing a range of frequencies and their corresponding gain measurements.



Radiated Composite Gain of 2.4GHz and 5GHz

Appendix A

Table with multiple columns (ID, Model, Gain values) containing radiated composite gain data for various models across different frequencies.

Model	1001	1002	1003	1004	1005	1006	1007	1008	1009	1010	1011	1012	1013	1014	1015	1016	1017	1018	1019	1020	1021	1022	1023	1024	1025
01071	3.0891	3.0891	3.0891	3.0891	3.0891	3.0891	3.0891	3.0891	3.0891	3.0891	3.0891	3.0891	3.0891	3.0891	3.0891	3.0891	3.0891	3.0891	3.0891	3.0891	3.0891	3.0891	3.0891	3.0891	3.0891



Antenna Pattern of 2.4GHz and 5GHz

Table with 12 columns and 1000 rows of numerical data representing antenna patterns at 2.4GHz and 5GHz. The table is divided into 20 sections (01 to 20) and includes sub-sections like 'Table 1', 'Table 2', 'Table 3', and 'Table 4'.



Antenna Pattern of 2.4GHz and 5GHz

Appendix B

Table with columns for frequency (e.g., 6170, 6175, ..., 6190 MHz) and antenna gain (Gain) for various frequencies. The table is organized in groups of 10 columns per frequency range.

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

