



Antenna Composite Gain Test Report

Equipment	Catalyst Wireless 9162I Series Wi-Fi 6E Access Point
Brand Name	CISCO
Model Name	CW9162I-B, CW9162I-MR
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. 03, 2022
Start Test Date	Mar. 03, 2022
Final Test Date	Mar. 03, 2022

Approved by: Sam Chen

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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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						
	1TX	2TX	1TX	2TX					
2G 5G 5.9G Ant1	1	2	1	2	WNC	95XEAJ15.G19	PIFA	I-PEX	2.4GHz, 5GHz UNII 1~4
2G 5G 5.9G Ant2	-	1	-	1	WNC	95XEAJ15.G20	PIFA	I-PEX	2.4GHz, 5GHz UNII 1~4

Note:

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

2G 5G 5.9G Ant1 can be use as transmitting antenna.

2G 5G 5.9G Ant1~2 can be used as receiving antennas.

2G 5G 5.9G Ant1~2 could receive simultaneously.

2.4GHz, 5GHz Operation Mode (2TX/2RX):

2G 5G 5.9G Ant1~2 can be use as transmitting antenna.

2G 5G 5.9G Ant1~2 could transmitting simultaneously.

2G 5G 5.9G Ant1~2 can be used as receiving antennas.

2G 5G 5.9G Ant1~2 could 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
5850-5895	5885



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	22-23 / 40-50	Mar. 03, 2022

Note:

Testing Site Information

Brand Name: TDK

Dimension: 11m*6m*6m

Characteristic: Fully Anechoic Chamber

4. Test Facility and Configuration

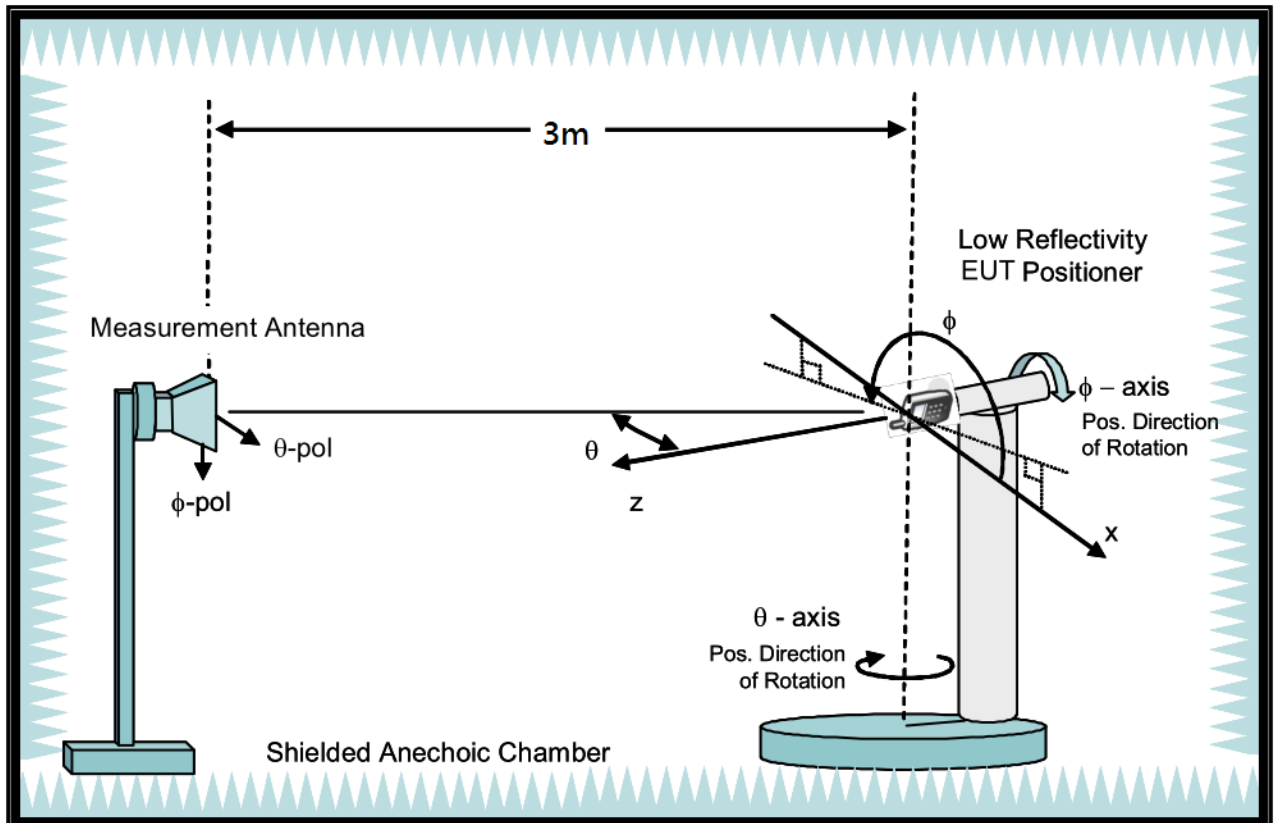
Test configuration: Reference to CITA OTA distributed-axes system configuration.

Chamber: Fully Anechoic Chamber.

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

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

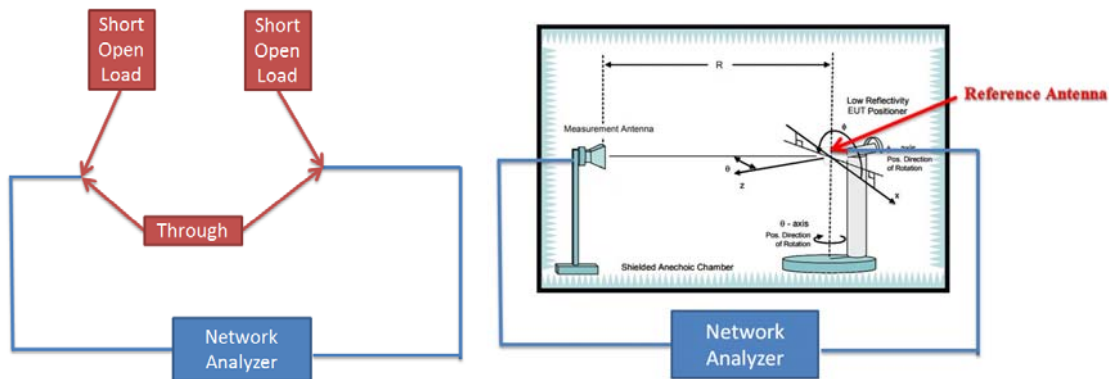
#Reference to CTIA "ctia-test-plan-for-wireless-device-over-the-air-performance-ver-3-7-1"



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:

$$G \text{ reading (dB)} = 20 \cdot \log(V_2/V_1) = 10 \cdot \log(P_2/P_1)$$

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	5.885G
Ant. 1 (dBi)	2.68	1.75	0.53	1.27	1.64	-0.32
Ant. 2 (dBi)	1.51	0.56	1.55	1.53	0.47	2.06
DG [1SS] (dBi)	5.12	4.19	4.07	4.41	4.08	3.96
Polarization	Theta	Theta	Theta	Theta	Theta	Theta
Θ (°)	60	60	45	45	60	45
Φ (°)	255	210	225	210	195	135

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	5.885G
Ant. 1 [10^(G/20)]	10^(2.68/20)	10^(1.75/20)	10^(0.53/20)	10^(1.27/20)	10^(1.64/20)	10^(-0.32/20)
Ant. 2 [10^(G/20)]	10^(1.51/20)	10^(0.56/20)	10^(1.55/20)	10^(1.53/20)	10^(0.47/20)	10^(2.06/20)
Ant. 1 [10^(G/20)] value	1.361	1.223	1.063	1.157	1.208	0.964
Ant. 2 [10^(G/20)] value	1.19	1.067	1.195	1.193	1.056	1.268
Sum All Antenna [Amax]	2.551	2.29	2.258	2.35	2.263	2.231
DG [10*log(Amax^2/Nant)]	5.12	4.19	4.07	4.41	4.08	3.96

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

Frequency (Hz)	2.45G
Ant. 1 Max Gain (dBi)	2.74
Ant. 2 Max Gain (dBi)	2.51
Ant. 1 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/60/105
Ant. 2 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/45/45
Max Gain (dBi)	2.74
DG [1SS] (dBi)	5.12
DG [2SS] (dBi)	2.74

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.

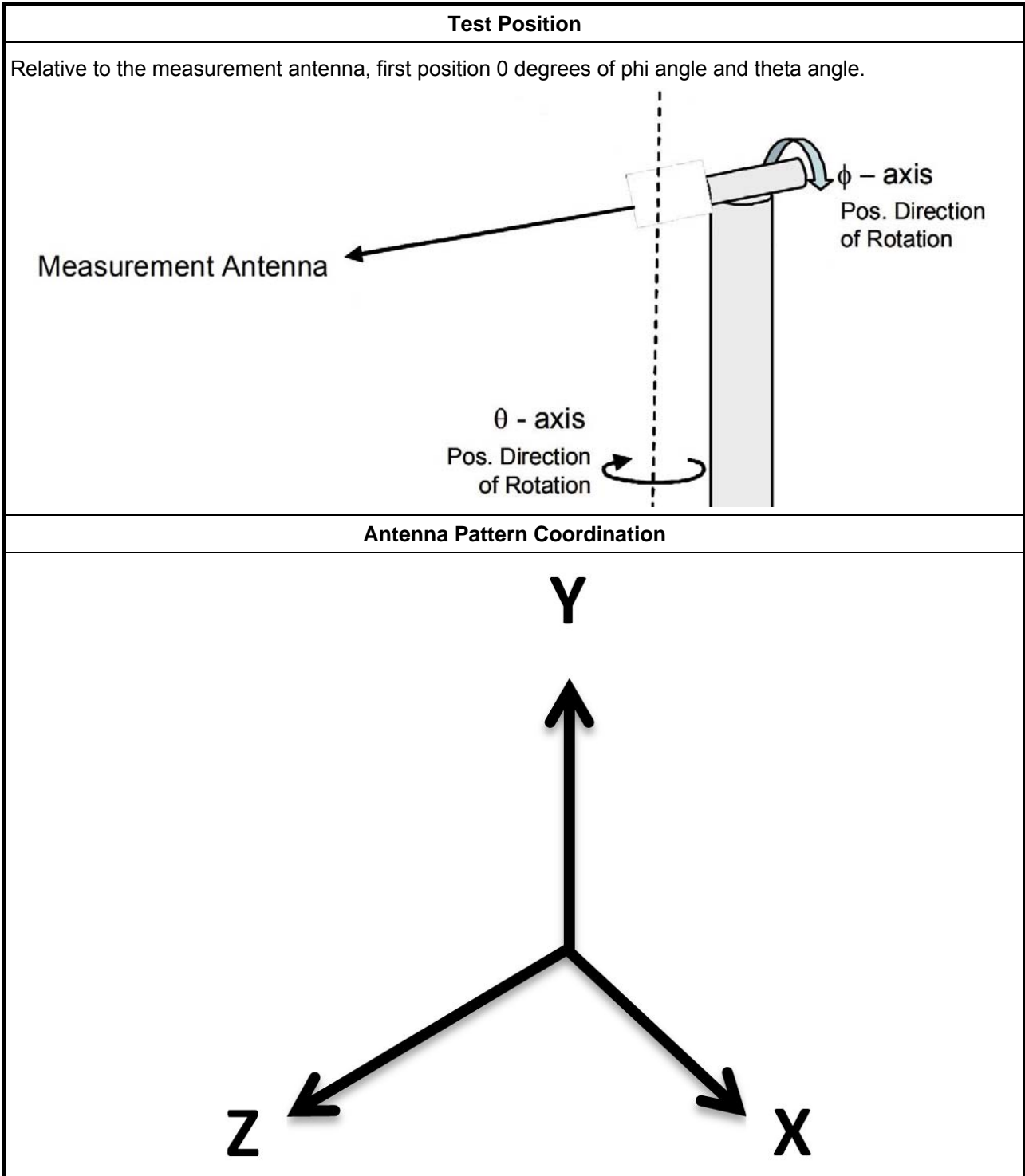


Frequency (Hz)	5.2G	5.3G	5.6G	5.785G	5.885G
Ant. 1 Max Gain (dBi)	1.75	1.67	1.8	1.64	1.45
Ant. 2 Max Gain (dBi)	2.13	2.37	1.82	1.5	2.06
Ant. 1 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/60/210	Theta/60/225	Theta/75/270	Theta/60/195	Theta/75/210
Ant. 2 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/60/135	Theta/60/135	Theta/60/135	Theta/75/180	Theta/45/135
Max Gain (dBi)	2.13	2.37	1.82	1.64	2.06
DG [1SS] (dBi)	4.19	4.07	4.41	4.08	3.96
DG [2SS] (dBi)	2.13	2.37	1.82	1.64	2.06

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.

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.

N.C.R. means Non-Calibration required.



11. Test Results

Please refer to the appendix.

Appendix A – Radiated Composite Gain of 2.4GHz, 5GHz UNII-1~UNII-4.....	Page 15
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Freq(Hz)	2.45G	5.2G	5.3G	5.6G	5.785G	5.885G
Ant. 1 Max Gain (dBi)	2.74	1.75	1.67	1.8	1.64	1.45
Ant. 2 Max Gain (dBi)	2.51	2.13	2.37	1.82	1.5	2.06
Ant. 1 Polarization/θ(°)/φ(°)	Theta/60/105	Theta/60/210	Theta/60/225	Theta/75/270	Theta/60/195	Theta/75/210
Ant. 2 Polarization/θ(°)/φ(°)	Theta/45/45	Theta/60/135	Theta/60/135	Theta/60/135	Theta/75/180	Theta/45/135
Max Gain (dBi)	2.74	2.13	2.37	1.82	1.64	2.06
DG [1SS] (dBi)	5.12	4.19	4.07	4.41	4.08	3.96
DG [2SS] (dBi)	2.74	2.13	2.37	1.82	1.64	2.06



DG 1SS Result

Table with columns for Freq(Hz), DG(dBi), and various Phi angles (0 to 345 degrees) for frequencies 2.45G, 5.2G, 5.3G, and 5.6G. The table contains numerical gain data for each angle and frequency combination.



Radiated Composite Gain Data_2.4GHz, 5GHz UNII-1~UNII-4

Appendix A

Table with columns for DG(dBi), Azimuth (Phi), and Elevation (Theta) for frequencies 5.6G, 5.785G, and 5.885G. It contains 24 columns of gain data for each frequency and elevation angle.



Gain Result

Table with columns: Freq(Hz), Gain, Phi, Ant. 1, and various Phi angles (0 to 345 degrees) for frequencies 2.45G, 5.2G, 5.3G, and 5.6G.



Radiated Composite Gain Data_2.4GHz, 5GHz UNII-1~UNII-4

Appendix A

Table with columns for Gain, Azimuth (Theta), and Elevation (Phi) for various frequencies (5.6G, 5.785G, 5.885G, 2.45G) and antenna configurations. The table contains numerical gain values for each combination of frequency, antenna, and angle.



Radiated Composite Gain Data_2.4GHz, 5GHz UNII-1~UNII-4

Appendix A

Table with columns for frequency (2.45G, 5.2G, 5.3G, 5.6G), gain, and various angles (Theta and Phi) from 0 to 180 degrees. The table contains numerical data for each combination of frequency and angle.



Radiated Composite Gain Data_2.4GHz, 5GHz UNII-1~UNII-4

Appendix A

Table with columns for frequency (5.6G, 5.785G, 5.885G), gain, and various angles (Theta and Phi) from 0 to 180 degrees. Includes numerical data and some highlighted values like 1.82, 1.5, and 2.06.



Total Gain Data

Table with columns: Freq(Hz), Pol., Total, Ant. 1, and 24 directional gain columns (Phi(0) to Phi(345)). Rows are grouped by frequency (2.45G, 5.2G, 5.3G, 5.6G, 5.785G, 5.885G, 2.45G) and include gain values for various angles.



Antenna Pattern_2.4GHz, 5GHz UNII-1~UNII-4

Appendix B

Table with columns for Frequency (5.2G, 5.3G, 5.6G, 5.785G, 5.885G), Gain, and various Azimuth (Theta) and Elevation (Phi) angles. It contains numerical data for antenna patterns across multiple frequencies and angles.

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

