

Antenna Report

FCC ID: A4RGE1GQ

Aug. 19th , 2025

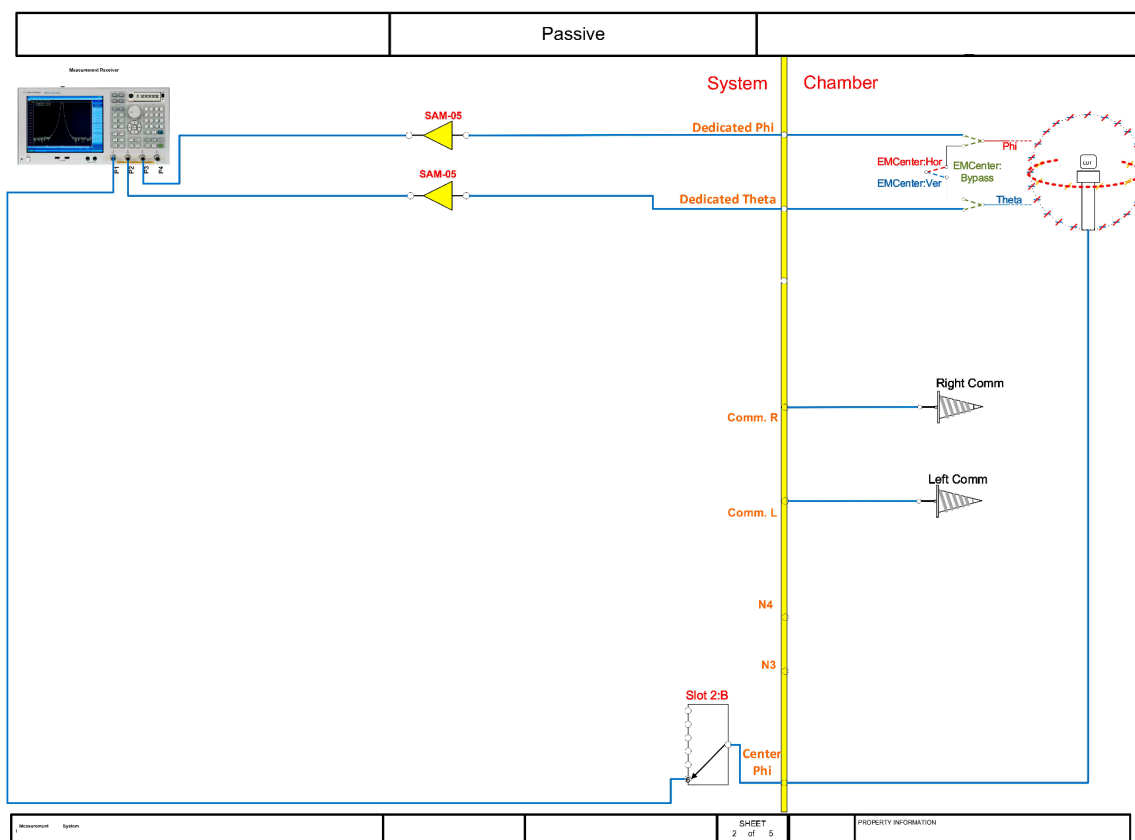
Google LLC

1. Test Method

The antenna gains are obtained through measurements in a fully anechoic OTA chamber with a 3D positioner.

Measurements are taken in discrete steps in theta and phi direction, data is being recorded using a network analyzer (passive) for both theta and phi polarizations at each position resulting in a 3D gain pattern. Step size is <30 deg along both axes.

Gain is derived directly through spatial averaging of VNA S21 measurements (passive measurement).



2. Test Equipment

Site Description	Chamber Manufacturer	Type
Muilt-Probe Anechoic Chamber	ETS-Lindgren	Fully Anechoic
Software Version	g.OTA Ver:2.6.1	
Site location	Far Eastern Rd., No. 8, Banqiao Dist., New Taipei City 220, Taiwan	
Prepare by	jasonchlin/jasonjccheng	
Test Date	July 2025	

Description	Manufacturer	Model	Calibration Date	Due Date
Network Analyzer	Agilent	E5071C	Dec. 30, 2024	Dec. 30, 2025

Test completion Date : 07/10/2025

To provide accurate antenna gain values, the chamber is calibrated with the measured path loss. The block diagram below represents the setup of the site path loss. Path loss is provided for both polarities for all WLAN frequency ranges.

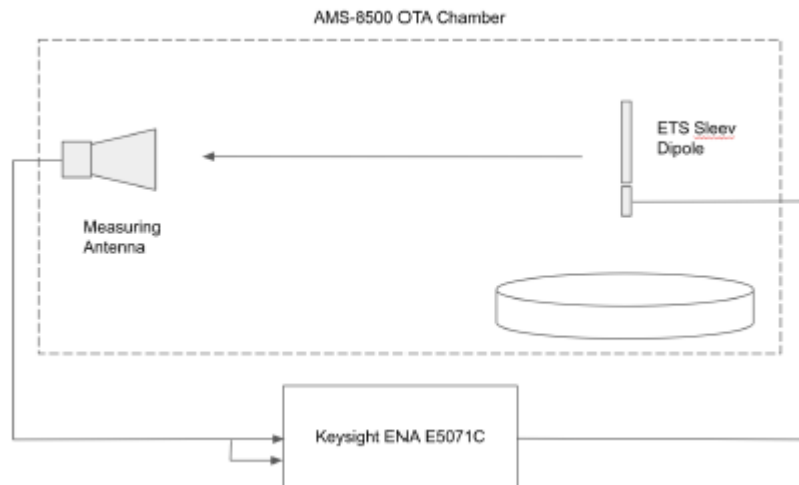


Figure: Block Diagram of Path Loss

H-Pol Path Loss																							
Freq (MHz)	Ant1 (dBm)	Ant2 (dBm)	Ant3 (dBm)	Ant4 (dBm)	Ant5 (dBm)	Ant6 (dBm)	Ant7 (dBm)	Ant8 (dBm)	Ant9 (dBm)	Ant10 (dBm)	Ant11 (dBm)	Ant12 (dBm)	Ant13 (dBm)	Ant14 (dBm)	Ant15 (dBm)	Ant16 (dBm)	Ant17 (dBm)	Ant18 (dBm)	Ant19 (dBm)	Ant20 (dBm)	Ant21 (dBm)	Ant22 (dBm)	Ant23 (dBm)
2402	-20.96	-19.79	-20.91	-20.72	-20.91	-20.67	-21.57	-22.84	-21.89	-20.46	-20.92	-21.08	-21.09	-23.03	-21.76	-21.72	-21.52	-21.27	-21.9	-20.25	-22.76	-20.18	-19.98
2412	-20.99	-19.94	-21.01	-20.75	-20.98	-20.77	-21.67	-22.96	-22.03	-20.57	-20.98	-21.12	-21.19	-23.04	-21.93	-21.82	-21.63	-21.27	-21.95	-20.39	-22.87	-20.18	-20.00
2437	-21.34	-20.32	-21.35	-21.11	-21.32	-21.13	-22.11	-23.34	-22.4	-20.99	-21.33	-21.47	-21.57	-23.42	-22.23	-22.19	-21.97	-21.58	-22.41	-20.79	-23.21	-20.46	-20.36
2462	-21.18	-20.2	-21.22	-21.02	-21.14	-21.13	-21.99	-23.2	-22.31	-20.92	-21.15	-21.45	-21.42	-23.33	-22.22	-22.11	-21.87	-21.5	-22.27	-20.73	-23.1	-20.31	-20.21
2480	-21.39	-20.08	-21.33	-21.13	-21.28	-21.02	-21.85	-23.15	-22.22	-20.82	-21.39	-21.35	-21.33	-23.26	-22.1	-22.23	-21.97	-21.74	-22.12	-20.59	-22.97	-20.54	-20.4
5150	-27.32	-26.77	-27.5	-27.4	-27.64	-28.14	-27.77	-28.44	-28.23	-27.43	-27.92	-27.56	-27.54	-27.76	-28.05	-27.97	-27.98	-27.85	-27.71	-27.18	-27.83	-26.86	-26.57
5230	-27.41	-26.83	-27.62	-27.35	-27.28	-28.14	-27.94	-28.27	-28.23	-27.48	-28	-27.53	-27.72	-27.87	-28.11	-28.22	-28.27	-27.98	-27.98	-27.16	-27.79	-26.92	-26.57
5250	-27.81	-27.28	-28.05	-27.88	-28.21	-28.56	-28.16	-28.81	-28.74	-27.87	-28.31	-27.94	-28.07	-28.13	-28.58	-28.52	-28.42	-28.1	-28.25	-27.83	-28.31	-27.36	-27.08
5310	-27.93	-27.3	-28.09	-27.94	-28.04	-28.23	-28.08	-28.87	-28.62	-27.98	-28.41	-27.9	-28.23	-28.26	-28.51	-28.3	-28.24	-27.96	-28.25	-27.8	-28.23	-27.5	-27.29
5340	-28.2	-27.63	-28.26	-27.89	-28.09	-28.91	-28.33	-28.78	-28.93	-27.99	-28.53	-28.21	-28.39	-28.29	-28.84	-28.99	-28.86	-28.52	-28.64	-27.91	-28.48	-27.56	-27.3
5480	-27.94	-27.57	-28.11	-27.79	-27.67	-28.38	-28.14	-28.96	-28.5	-27.76	-28.46	-27.95	-28.17	-28.01	-28.47	-28.49	-28.45	-28.03	-28.25	-27.56	-28.54	-27.29	-27.34
5530	-28.02	-27.6	-27.97	-27.71	-27.57	-28.24	-28.02	-28.87	-28.47	-27.83	-28.41	-27.88	-28.34	-28.2	-28.38	-28.38	-28.24	-27.92	-28.22	-27.59	-28.4	-27.27	-27.32
5710	-28.41	-27.59	-28.23	-28.08	-27.94	-28.58	-28.39	-29.13	-28.98	-28.18	-28.54	-28.3	-28.57	-28.46	-28.89	-28.69	-28.5	-28.16	-28.25	-27.88	-28.36	-27.59	-27.52
5795	-29.05	-28.27	-29.03	-28.62	-28.48	-29.25	-28.93	-29.73	-29.51	-28.62	-29.17	-28.91	-29.12	-28.97	-29.32	-29.27	-29.18	-28.68	-28.9	-28.44	-28.98	-28.1	-28.08
5835	-29.27	-28.62	-29.44	-28.97	-28.95	-29.63	-29.24	-30.02	-29.8	-28.92	-29.53	-29.26	-29.52	-29.35	-29.64	-29.37	-29.39	-29.04	-29.35	-28.66	-29.26	-28.41	-28.43
5855	-29.21	-28.34	-29.23	-28.79	-28.66	-29.24	-29.23	-29.96	-29.78	-28.95	-29.37	-29.23	-29.27	-29.2	-29.47	-29.51	-29.5	-29.3	-29.07	-28.7	-29.24	-28.46	-28.31
5875	-29.09	-28.47	-29.35	-29.22	-29.26	-29.7	-29.54	-30.02	-29.97	-29.06	-29.43	-29.3	-29.63	-29.47	-29.77	-29.66	-29.32	-29.39	-29.3	-28.79	-29.2	-28.41	-28.57
5925	-29.72	-28.98	-29.61	-29.68	-29.43	-29.97	-30.08	-30.64	-30.38	-29.68	-29.81	-29.87	-30.04	-30.17	-30.31	-30.16	-29.61	-29.66	-29.49	-29.14	-29.56	-28.89	-29.13
6175	-29.67	-29	-29.53	-29.64	-29.36	-29.98	-29.88	-30.6	-30.39	-29.53	-29.95	-29.84	-30.83	-30.04	-30.33	-30.39	-29.75	-29.87	-29.79	-29.19	-29.79	-28.89	-29.06
6425	-31.4	-30.92	-31.74	-31.32	-31.32	-31.74	-31.77	-32.37	-32.15	-31.47	-31.73	-31.75	-31.72	-31.81	-32.09	-32.02	-31.59	-32.02	-31.67	-31.27	-31.73	-30.92	-30.74
6525	-31.96	-31.54	-32.08	-31.84	-31.88	-32.23	-32.47	-32.98	-32.66	-31.88	-32.39	-32.34	-32.15	-32.26	-32.82	-32.63	-32.05	-32.42	-32.29	-31.6	-32.08	-31.55	-31.2
6875	-33.89	-33.17	-34.03	-33.68	-33.41	-34.01	-34	-34.64	-34.38	-33.78	-34.14	-33.98	-33.85	-33.89	-34.43	-34.2	-33.72	-34.19	-33.96	-33.34	-33.88	-33.16	-33.22
7085	-33.45	-32.92	-33.62	-33.28	-33	-33.52	-33.55	-34.33	-33.9	-33.23	-33.81	-33.3	-33.39	-33.43	-34.03	-33.71	-33.09	-33.29	-33.28	-33.02	-33.49	-32.8	-32.92

V-Pol Path Loss																							
Freq (MHz)	Ant1 (dBm)	Ant2 (dBm)	Ant3 (dBm)	Ant4 (dBm)	Ant5 (dBm)	Ant6 (dBm)	Ant7 (dBm)	Ant8 (dBm)	Ant9 (dBm)	Ant10 (dBm)	Ant11 (dBm)	Ant12 (dBm)	Ant13 (dBm)	Ant14 (dBm)	Ant15 (dBm)	Ant16 (dBm)	Ant17 (dBm)	Ant18 (dBm)	Ant19 (dBm)	Ant20 (dBm)	Ant21 (dBm)	Ant22 (dBm)	Ant23 (dBm)
2402	-20.94	-21.1	-21.49	-21.6	-21.01	-21.04	-21.52	-23.39	-22.48	-20.08	-21.26	-20.7	-20.97	-23.48	-22.18	-22.77	-21.61	-20.95	-22.15	-20.79	-22.59	-20.87	-20.17
2412	-21.04	-21.09	-21.54	-21.66	-21.14	-21.12	-21.72	-23.61	-22.63	-20.24	-21.3	-20.89	-21.21	-23.57	-22.35	-22.92	-21.67	-21.01	-22.2	-20.94	-22.66	-21.02	-20.37
2437	-21.4	-21.37	-21.82	-21.95	-21.48	-21.4	-22.03	-23.91	-22.93	-20.59	-21.61	-21.16	-21.57	-23.92	-22.61	-23.24	-22.04	-21.32	-22.5	-21.2	-22.95	-21.26	-20.64
2462	-21.2	-21.16	-21.62	-21.78	-21.23	-21.21	-21.78	-23.73	-22.77	-20.45	-21.39	-21	-21.35	-23.68	-22.4	-23.05	-21.87	-21.16	-22.26	-21.03	-22.75	-20.95	-20.35
2480	-21.24	-21.16	-21.59	-21.73	-21.21	-21.2	-21.82	-23.69	-22.82	-20.46	-21.38	-20.93	-21.33	-23.69	-22.4	-23.04	-21.89	-21.15	-22.27	-20.98	-22.68	-20.86	-20.27
5150	-27.11	-26.09	-27.58	-27.84	-27.75	-28.04	-27.84	-28.24	-27.96	-27.42	-27.8	-27.45	-27.66	-28.04	-28.33	-27.7	-27.87	-27.58	-28.07	-26.69	-27.71	-26.58	-26.29
5230	-26.94	-25.91	-27.47	-27.78	-27.6	-27.83	-27.68	-28.21	-27.91	-27.35	-27.69	-27.31	-27.54	-27.81	-28.15	-27.59	-27.68	-27.49	-27.88	-26.75	-27.63	-26.58	-26.27
5250	-27.08	-26.11	-27.67	-27.82	-27.77	-27.93	-27.92	-28.43	-28.1	-27.57	-27.94	-27.5	-27.72	-28.03	-28.32	-27.8	-27.96	-27.75	-28.09	-26.93	-27.84	-26.82	-26.54
5310	-27.05	-26.02	-27.59	-27.6	-27.51	-27.65	-27.79	-28.39	-28.06	-27.53	-27.92	-27.37	-27.54	-27.87	-28.13	-27.66	-27.92	-27.63	-28.02	-27.01	-27.74	-26.8	-26.59
5340	-27.57	-26.53	-27.97	-28.03	-27.8	-28.13	-28.21	-28.71	-28.48	-27.92	-28.27	-27.83	-27.9	-28.24	-28.44	-27.93	-28.24	-28.08	-28.42	-27.47	-28.2	-27.24	-27.17
5480	-28.36	-27.37	-28.77	-28.25	-28.3	-28.55	-28.64	-28.99	-28.89	-28.3	-28.5	-28.25	-28.25	-28.79	-28.99	-28.32	-28.52	-28.29	-28.79	-28.29	-28.7	-27.84	-27.78
5530	-28.55	-27.52	-28.81	-28.19	-28.25	-28.53	-28.74	-29.08	-28.89	-28.54	-28.69	-28.41	-28.53	-29.03	-29.11	-28.27	-28.61	-28.37	-28.89	-28.32	-29	-27.98	-27.88
5710	-28.29	-27.26	-28.93	-28.58	-28.44	-28.58	-28.96	-29.41	-29.06	-28.69	-28.75	-28.69	-28.79	-29.17	-29.34	-28.52	-28.77	-28.55	-28.98	-28.18	-29.01	-28.08	-27.85
5795	-28.29	-27.31	-29.1	-28.75	-28.42	-28.77	-29.23	-29.46	-29.13	-28.73	-28.87	-28.84	-28.85	-29.28	-29.38	-28.55	-28.82	-28.65	-29.07	-28.14	-28.84	-28.04	-27.89
5835	-28.39	-27.48	-29.24	-28.86	-28.55	-28.93	-29.64	-29.54	-29.21	-28.86	-29.02	-28.94	-28.97	-29.41	-29.51	-28.65	-28.94	-28.88	-29.24	-28.3	-28.89	-28.07	-27.99
5855	-28.34	-27.38	-29.3	-28.93	-28.52	-28.93	-29.65	-29.55	-29.33	-28.84	-28.98	-29.04	-28.95	-29.43	-29.56	-28.66	-29.02	-28.84	-29.27	-28.24	-28.91	-28.09	-28.02
5875	-28.58	-27.63	-29.41	-29.04	-28.74	-29.03	-29.97	-29.75	-29.39	-29.07	-29.22	-29.12	-29.14	-29.59	-29.71	-28.8	-29.07	-29.15	-29.41	-28.49	-28.99	-28.14	-28.07
5895	-28.89	-28.19	-29.59	-29.29	-28.99	-29.14	-30.07	-29.85	-29.49	-29.17	-29.32	-29.22	-29.23	-29.69	-29.81	-28.95	-29.24	-29.39	-29.72	-28.83	-29.04	-28.19	-28.07

4. **Test Setup**

See separate appendix document for pictures of the test setup in this filing.

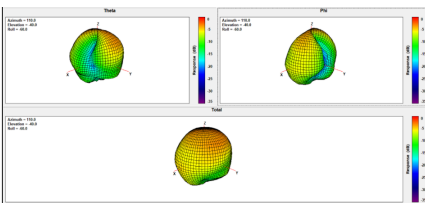
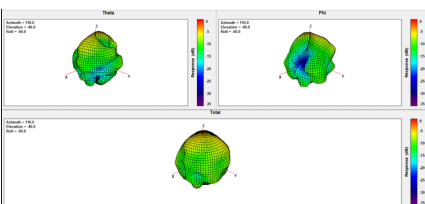
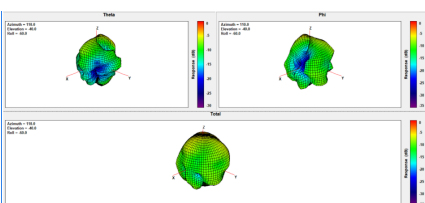
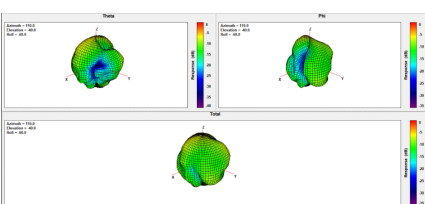
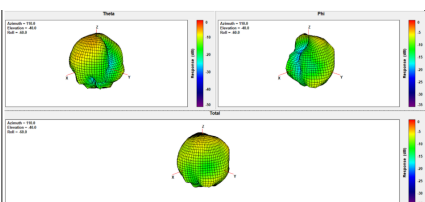
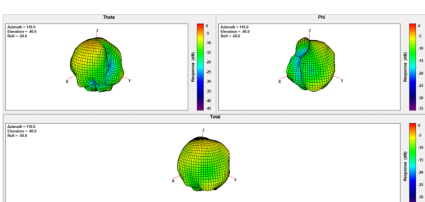
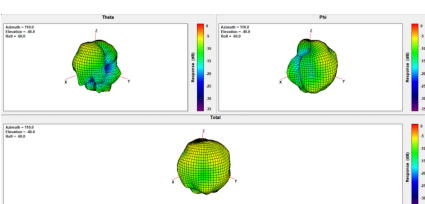
5. **Antenna Type**

Antenna	Type
Ant 3	IFA
Ant 4	IFA

6. **WLAN/BT Antenna Test Data**

Ant	Band	Frequency	Peak Gain(dBi)
Ant 4	WiFi/BT 2.4 GHz	2402 - 2480 MHz	-3.2
Ant 3	WiFi/BT 2.4 GHz	2402 - 2480 MHz	0.5
Ant 4	UNII-1	5150-5250 MHz	-2.3
	UNII-2A	5250-5350 MHz	-1.8
	UNII-2C	5470 -5725 MHz	-2.5
	UNII-3	5725 - 5850 MHz	-2.2
	UNII-4	5850 - 5895 MHz	-2.0
	UNII-5	5925 - 6425 MHz	-2.1
	UNII-6	6425 - 6525 MHz	-2.4
	UNII-7	6525 - 6875 MHz	0.7
	UNII-8	6875 - 7125 MHz	1.6
Ant 3	UNII-1	5150-5250 MHz	-3.5
	UNII-2A	5250-5350 MHz	-2.2
	UNII-2C	5470 -5725 MHz	-1.9
	UNII-3	5725 - 5850 MHz	-2.0
	UNII-4	5850 - 5895 MHz	-2.3
	UNII-5	5925 - 6425 MHz	-2.4
	UNII-6	6425 - 6525 MHz	-5.0
	UNII-7	6525 - 6875 MHz	-5.0
	UNII-8	6875 - 7125 MHz	-8.5

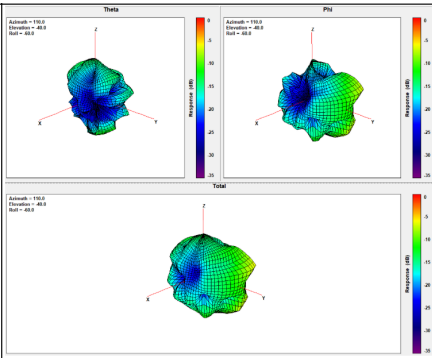
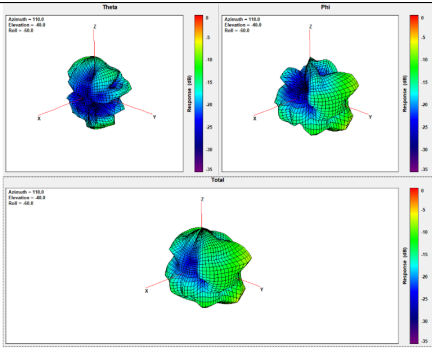
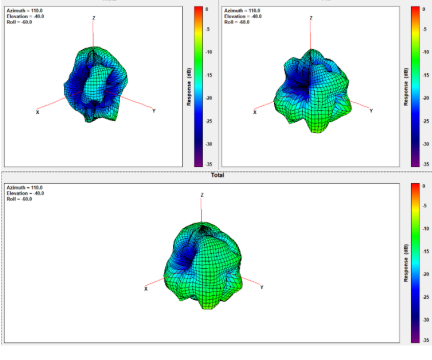
7. Radiation Plots for Max Gain Plane

ANT	Frequency	Pattern
ANT 4	2402 - 2480 MHz	
ANT 4	5150-5250 MHz	
ANT 4	5250-5350 MHz	
ANT 4	5470 -5725 MHz	
ANT 4	5725 - 5850 MHz	
ANT 4	5850 - 5895 MHz	
ANT 4	5925 - 6425 MHz	

ANT 4	6425 - 6525 MHz	
ANT 4	6525 - 6875 MHz	
ANT 4	6875 - 7125MHz	

ANT 3	2402 - 2480 MHz	
ANT 3	5150-5250 MHz	
ANT 3	5250-5350 MHz	

ANT 3	5470 -5725 MHz	
ANT 3	5725 - 5850 MHz	
ANT 3	5850 - 5895 MHz	
ANT3	5925 - 6425 MHz	

ANT 3	6425 - 6525 MHz	
ANT 3	6525 - 6875 MHz	
ANT 3	6875 - 7125MHz	

8. Antenna Composite Gain Test Method

The great-circle-cut method, whereby the measuring antenna remains in fixed position while the EUT is rotated about two axes in sequential order. The radiated RF performance of the EUT is measured by sampling the radiated transmit power of the mobile at various locations surrounding the device. A three-dimensional characterization of the transmit performance of the EUT is pieced together by analyzing the data from the spatially distributed measurements.

Data points are taken at every 15 degrees in the theta (θ) and phi (φ) axes to fully characterize the EUT's Far-Field radiation pattern and total radiated power. All of the measured power values are then integrated

The correlated gain is calculated of each degree in the specific spatial domain of the sphere generated by each antenna, and the highest among them is extracted to be the correlation gain of the represented one.

Gain formula of the correlation (direction gain) is based on KDB 662911 D01, F(2)(e)(ii), and listed in the following:

$$DirectionalGain = 10 \cdot \log \left[\frac{\sum_{j=1}^{N_{SS}} \left\{ \sum_{k=1}^{N_{ANT}} g_{j,k} \right\}^2}{N_{ANT}} \right]$$

where

Each antenna is driven by no more than one spatial stream;

N_{SS} = the number of independent spatial streams of data;

N_{ANT} = the total number of antennas

$g_{j,k} = 10^{G_k / 20}$ if the k th antenna is being fed by spatial stream j , or zero if it is not;
 G_k is the gain in dBi of the k th antenna.

Ant	Band	Frequency (MHz)	Correlated Gain(dBi)	Uncorrelated Gain(dBi)
Ant 4 + 3	UNII-5	5925 - 6425	-3.3	-5.8
	UNII-6	6425 - 6525	-4.5	-6.3
	UNII-7	6525 - 6875	-1.2	-2.2
	UNII-8	6875 - 7125	-0.6	-1.2