

GALTRONICS

WHEN CONNECTIONS COUNT

Antenna Measurement data



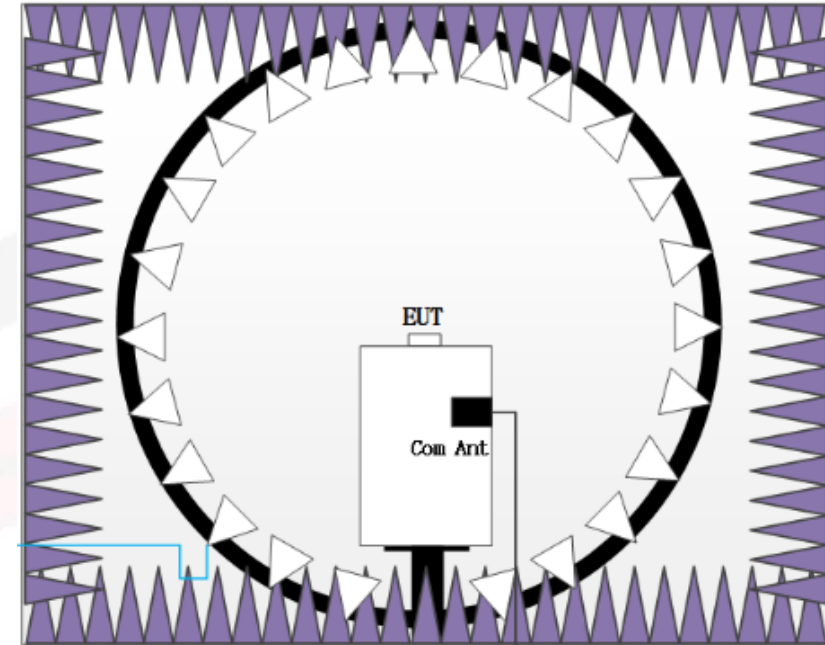
Introduction

This report provides Wi-Fi antenna passive measurement results which include:

- » General Information
- » Antenna Measurement System Information
- » Test Procedure
- » DUT Information
- » Single Antenna Test Result
- » Directional Gain Result
- » Set-up Photo

General Information

- Antenna Vendor : HWA-TECH
- Test Date : 2025/07/14
- Test Engineer : Zack
- Measurement System : HWA-TECH SP24
- Software Name : Quick OTA
- Software Version : 2.0.3.829

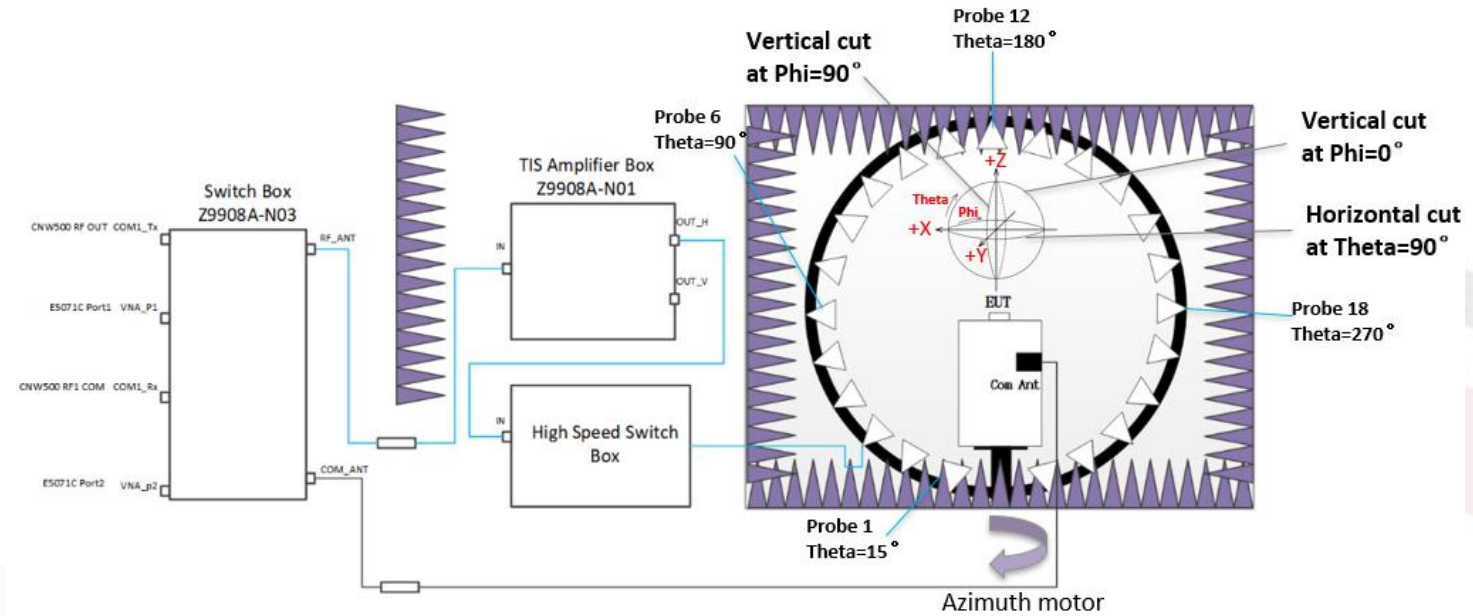


Antenna Measurement System Information

- Measurement System: HWA-TECH SP24 Chamber

Measurement setup:

- Pattern & Gain measurement
 1. HWA-TECH chamber (SP24)
 2. HWA-TECH program (Quick OTA)
 3. System overview
- Test item
 1. Antenna passive test 400MHz~7.5GHz

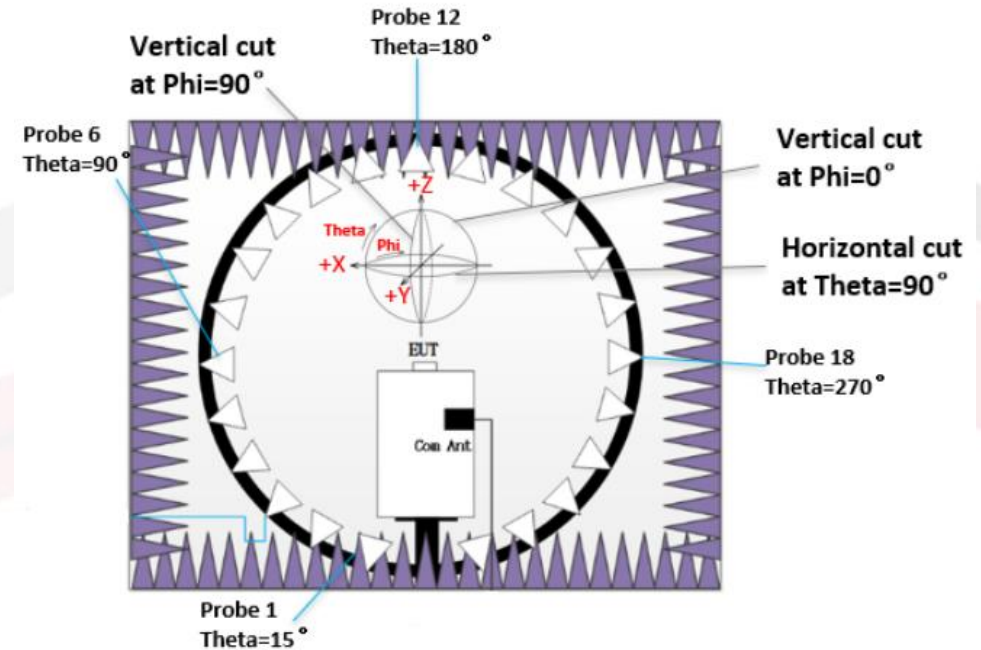


- Calibration Information

Description	Model No.	Serial #	Calibration Date	Calibration Until
Chamber	HWA-TECH SP24	NA	2025/07/04	2026/07/03
Network Analyzer	Keysight E5071C	MY46730234	2025/07/04	2026/07/03

Test Procedure

1. Place the device to be tested on the fixture and align it with the center of the chamber.
2. Connect the antenna cable to the RF connector of the chamber.
3. Use the SW to configure parameters (antenna name, frequency points, measurement angles, antenna dimension), and then run the test SW (Quick OTA).
4. By phi from 0° to 360° and theta from 0° to 180° with a step size of 15 degrees, get the 3D data, including efficiency, peak gain, 2D and 3D radiation patterns.
5. This is far field test for antenna verification.
6. This is passive measurement, which means the device is off and not in any operating mode.



DUT Information - DUT Operation Mode

Support band	TX/RX	Operation mode
2.4G	2TX-2RX	11b/11g/11n/11ax/11be
5G UNII-1	2TX-2RX	11a/11n/11ac/11ax/11be
5G UNII-2a	2TX-2RX	11a/11n/11ac/11ax/11be
5G UNII-2c	2TX-2RX	11a/11n/11ac/11ax/11be
5G UNII-3	2TX-2RX	11a/11n/11ac/11ax/11be
5G UNII-4	2TX-2RX	11a/11n/11ac/11ax/11be
6G UNII-5	2TX-2RX	11a/11ax/11be
6G UNII-6	2TX-2RX	11a/11ax/11be
6G UNII-7	2TX-2RX	11a/11ax/11be
6G UNII-8	2TX-2RX	11a/11ax/11be

DUT Information - DUT Operation Mode

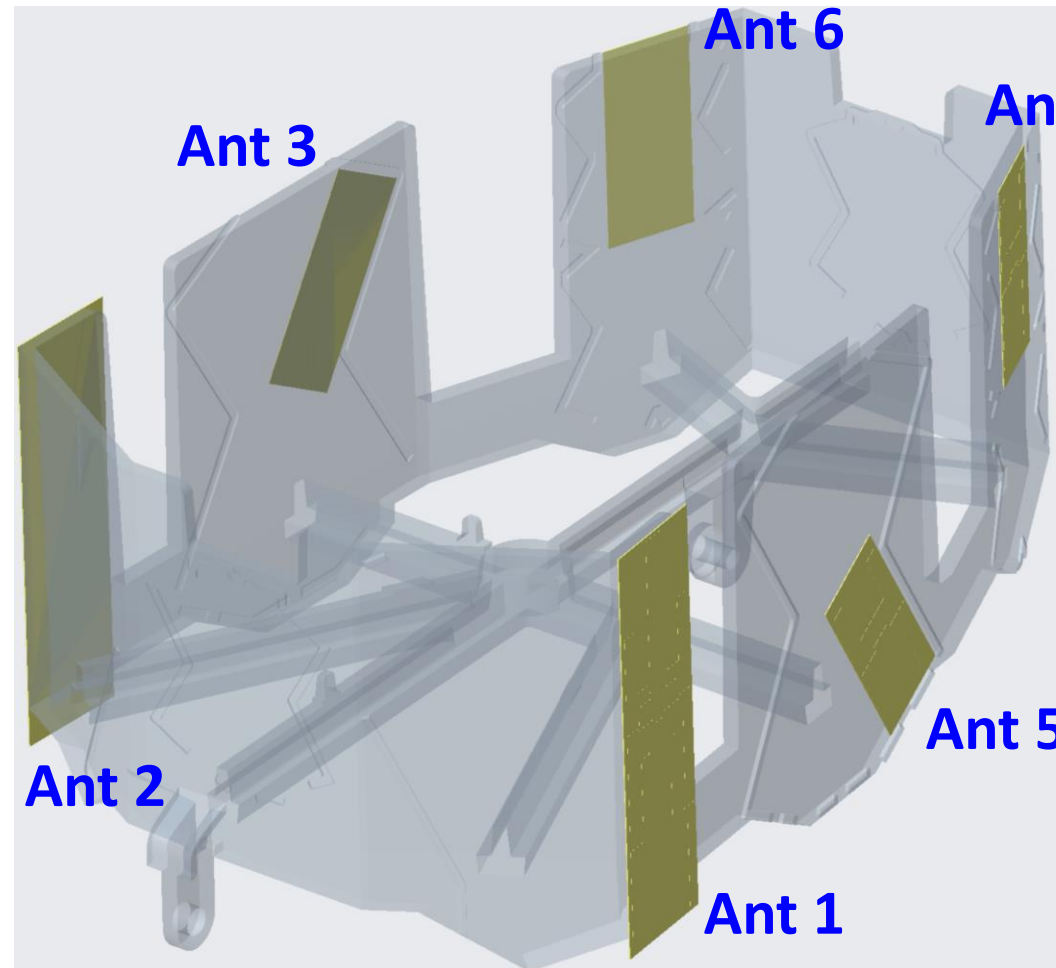
Band	Modulation Mode	CDD mode	Beamforming mode
2.4GHz	802.11b	Nss1	Not Support
	802.11g	Nss1	Not Support
	802.11n (HT20)	Nss1 / Nss2	Nss1 / Nss2
	802.11n (HT40)	Nss1 / Nss2	Nss1 / Nss2
	802.11n (VHT20)	Nss1 / Nss2	Nss1 / Nss2
	802.11n (VHT40)	Nss1 / Nss2	Nss1 / Nss2
	802.11ax (HE20)	Nss1 / Nss2	Nss1 / Nss2
	802.11ax (HE40)	Nss1 / Nss2	Nss1 / Nss2
	802.11be (EHT20)	Nss1 / Nss2	Nss1 / Nss2
	802.11be (EHT40)	Nss1 / Nss2	Nss1 / Nss2
5GHz	802.11a	Nss1	Not Support
	802.11n (HT20)	Nss1 / Nss2	Nss1 / Nss2
	802.11n (HT40)	Nss1 / Nss2	Nss1 / Nss2
	802.11ac (VHT20)	Nss1 / Nss2	Nss1 / Nss2
	802.11ac (VHT40)	Nss1 / Nss2	Nss1 / Nss2
	802.11ac (VHT80)	Nss1 / Nss2	Nss1 / Nss2
	802.11ac (VHT160)	Nss1 / Nss2	Nss1 / Nss2
	802.11ax (HE20)	Nss1 / Nss2	Nss1 / Nss2
	802.11ax (HE40)	Nss1 / Nss2	Nss1 / Nss2
	802.11ax (HE80)	Nss1 / Nss2	Nss1 / Nss2
	802.11ax (HE160)	Nss1 / Nss2	Nss1 / Nss2
	802.11be (EHT20)	Nss1 / Nss2	Nss1 / Nss2
	802.11be (EHT40)	Nss1 / Nss2	Nss1 / Nss2
	802.11be (EHT80)	Nss1 / Nss2	Nss1 / Nss2
	802.11be (EHT160)	Nss1 / Nss2	Nss1 / Nss2
	802.11be (EHT240)	Nss1 / Nss2	Nss1 / Nss2

Band	Modulation Mode	CDD mode	Beamforming mode
6GHz	802.11a	Nss1	Not Support
	802.11ax (HE20)	Nss1 / Nss2	Nss1 / Nss2
	802.11ax (HE40)	Nss1 / Nss2	Nss1 / Nss2
	802.11ax (HE80)	Nss1 / Nss2	Nss1 / Nss2
	802.11ax (HE160)	Nss1 / Nss2	Nss1 / Nss2
	802.11be (EHT20)	Nss1 / Nss2	Nss1 / Nss2
	802.11be (EHT40)	Nss1 / Nss2	Nss1 / Nss2
	802.11be (EHT80)	Nss1 / Nss2	Nss1 / Nss2
	802.11be (EHT160)	Nss1 / Nss2	Nss1 / Nss2
	802.11be (EHT240)	Nss1 / Nss2	Nss1 / Nss2
	802.11be (EHT360)	Nss1 / Nss2	Nss1 / Nss2

DUT Information - Antenna System information

Antenna No.	RF Chain No.	Brand	Model	Support Function	Antenna Type	Connector Type
Ant 1	0	Galtronics	02129140-08099-2	2.4G + 5G	Monopole	I-PEX
Ant 2	1	Galtronics	02129140-08099-1	2.4G + 5G	Monopole	I-PEX
Ant 3	0	Galtronics	02129475-08099-2	6G	Monopole	I-PEX
Ant 4	1	Galtronics	02129475-08099-4	6G	Monopole	I-PEX
Ant 5	2	Galtronics	02129475-08099-3	6G	Monopole	I-PEX
Ant 6	3	Galtronics	02129475-08099-1	6G	Monopole	I-PEX

DUT Information - Antenna Placement



Single Antenna Test Result - Antenna Peak Gain

Antenna NO.	Model	Test Frequency (MHz)	Peak Gain (dBi)
Ant 1	02129140-08099-2	2400	2.51
		2450	2.29
		2500	2.36
		5150	3.54
		5200	3.40
		5250	3.87
		5300	3.49
		5350	3.49
		5470	3.54
		5600	4.72
		5725	4.52
		5785	4.24
		5850	4.02
		5865	3.96
		5895	4.39
Ant 2	02129140-08099-1	2400	2.67
		2450	2.91
		2500	2.93
		5150	3.39
		5200	2.99
		5250	3.40
		5300	3.12
		5350	3.06
		5470	3.24
		5600	4.37
		5725	4.02
		5785	3.72
		5850	4.07
		5865	3.98
		5895	3.59

Single Antenna Test Result - Antenna Peak Gain

Antenna NO.	Model	Test Frequency (MHz)	Peak Gain (dBi)
Ant 3	02129475-08099-2	5925	4.12
		6175	4.14
		6425	3.31
		6475	4.49
		6525	4.92
		6695	4.87
		6875	3.59
		6995	4.11
		7115	4.28
Ant 4	02129475-08099-4	5925	4.31
		6175	4.92
		6425	5.14
		6475	5.28
		6525	4.42
		6695	4.67
		6875	4.38
		6995	4.95
		7115	4.96

Antenna NO.	Model	Test Frequency (MHz)	Peak Gain (dBi)
Ant 5	02129475-08099-3	5925	4.39
		6175	4.43
		6425	4.31
		6475	4.01
		6525	4.44
		6695	4.06
		6875	3.59
		6995	3.67
		7115	5.36
Ant 6	02129475-08099-1	5925	4.32
		6175	4.50
		6425	5.28
		6475	5.25
		6525	4.51
		6695	4.81
		6875	4.54
		6995	4.48
		7115	4.29

Single Antenna Test Result - 2D Radiation Pattern

- ◆ Refer to the attached file: Single Antenna Test Result - 2D Radiation Pattern



Directional Gain Result - Procedure

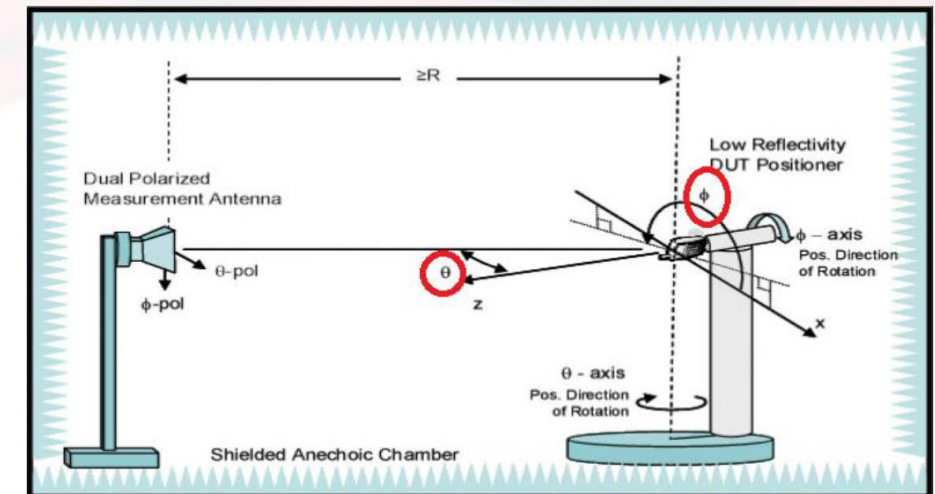
- Sub-divide the whole sphere surface into many 2x2 degree subsection.
- Measure the gain contributed from each antenna within each subsection position.
- Apply the KDB 662911 D01 correlated directional gain formula to calculate directional gain for each subsection.
- After all subsections have been evaluated, the largest calculated value among all positions evaluated is picked as the worst-case directional gain for the system and used in RF/EMC test report.

KDD 662911 D01 correlated directional gain formula

d) *Unequal antenna gains, with equal transmit powers.* For antenna gains given by $G_1, G_2, \dots, G_N$ dBi

- (i) If transmit signals are *correlated*, then

Directional gain = $10 \log[(10^{G_1/20} + 10^{G_2/20} + \dots + 10^{G_N/20})^2 / N_{\text{ANT}}]$ dBi [Note the “20”s in the denominator of each exponent and the square of the sum of terms; the object is to combine the signal levels coherently.]



The definition of (θ, Φ) in antenna raw data.

Directional Gain Result - Summary of Single antenna

Individual Antenna Maximum Peak Gain																
Frequency (MHz)		2400	2450	2500	5150	5200	5250	5300	5350	5470	5600	5725	5785	5850	5865	5895
Ant 1	Max. Gain (dBi)	2.51	2.29	2.36	3.54	3.40	3.87	3.49	3.49	3.54	4.72	4.52	4.24	4.02	3.96	4.39
	Polarization	Theta	Theta	Theta	Theta	Theta	Theta	Theta	Theta	Theta	Theta	Theta	Theta	Theta	Theta	Theta
	Axis: Theta(°)	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90
	Axis: Phi(°)	135	135	150	300	300	300	300	300	0	90	105	105	90	90	105
Ant 2	Max. Gain (dBi)	2.67	2.91	2.93	3.39	2.99	3.40	3.12	3.06	3.24	4.37	4.02	3.72	4.07	3.98	3.59
	Polarization	Theta	Theta	Theta	Theta	Theta	Theta	Theta	Theta	Theta	Theta	Theta	Theta	Theta	Theta	Theta
	Axis: Theta(°)	120	120	120	105	90	90	75	90	105	105	90	105	90	90	90
	Axis: Phi(°)	0	0	0	255	45	45	15	15	255	255	255	255	255	240	240

Individual Antenna Maximum Peak Gain										
Frequency (MHz)		5925	6175	6425	6475	6525	6695	6875	6995	7115
Ant 3	Max. Gain (dBi)	4.12	4.14	3.31	4.49	4.92	4.87	3.59	4.11	4.28
	Polarization	Theta	Theta	Theta	Theta	Theta	Theta	Phi	Phi	Phi
	Axis: Theta(°)	45	60	90	60	60	60	30	30	30
	Axis: Phi(°)	180	180	240	210	210	210	60	60	60
Ant 4	Max. Gain (dBi)	4.31	4.92	5.14	5.28	4.42	4.67	4.38	4.95	4.96
	Polarization	Theta	Theta	Theta	Theta	Theta	Phi	Phi	Phi	Phi
	Axis: Theta(°)	105	105	90	90	90	30	30	30	30
	Axis: Phi(°)	0	0	0	0	0	330	330	330	330
Ant 5	Max. Gain (dBi)	4.39	4.43	4.31	4.01	4.44	4.06	3.59	3.67	5.36
	Polarization	Theta	Theta	Theta	Theta	Theta	Theta	Theta	Theta	Phi
	Axis: Theta(°)	90	135	90	135	135	45	45	120	15
	Axis: Phi(°)	0	195	60	195	195	15	15	195	330
Ant 6	Max. Gain (dBi)	4.32	4.50	5.28	5.25	4.51	4.81	4.54	4.48	4.29
	Polarization	Theta	Theta	Theta	Theta	Theta	Theta	Theta	Theta	Phi
	Axis: Theta(°)	75	105	90	90	90	90	90	90	30
	Axis: Phi(°)	120	180	345	345	345	345	315	315	30

Directional Gain Result - Summary

Directional Gain _ Maximum Gain Value and Positions																
Frequency (MHz)		2400	2450	2500	5150	5200	5250	5300	5350	5470	5600	5725	5785	5850	5865	5895
Ant 1 + Ant 2	Max. Gain (dBi)	4.51	4.85	4.94	5.85	5.05	5.56	5.50	5.66	5.48	6.22	6.21	5.84	6.05	6.54	5.76
	Polarization	Theta	Theta	Theta	Theta	Theta	Theta	Theta	Theta	Theta	Theta	Theta	Theta	Theta	Theta	Theta
	Axis: Theta(°)	120	120	120	90	105	90	90	90	90	105	75	90	90	90	90
	Axis: Phi(°)	345	0	0	0	45	15	15	15	300	45	300	30	30	30	45

Individual Antenna gain corresponds to directional gain																
Frequency (MHz)		2400	2450	2500	5150	5200	5250	5300	5350	5470	5600	5725	5785	5850	5865	5895
Ant 1 (dBi)		0.64	0.63	0.81	3.44	1.14	2.24	2.29	2.22	3.15	3.81	2.64	3.44	2.36	3.10	2.69
Ant 2 (dBi)		2.29	2.91	2.93	2.19	2.85	2.85	2.68	3.06	1.73	2.56	3.73	2.18	3.68	3.94	2.81
Polarization		Theta	Theta	Theta	Theta	Theta	Theta	Theta	Theta	Theta	Theta	Theta	Theta	Theta	Theta	Theta
Axis: Theta(°)		120	120	120	90	105	90	90	90	90	105	75	90	90	90	90
Axis: Phi(°)		345	0	0	0	45	15	15	15	300	45	300	30	30	30	45

Directional Gain Result - Summary

Directional Gain _ Maximum Gain Value and Positions										
Frequency (MHz)		5925	6175	6425	6475	6525	6695	6875	6995	7115
Ant 3 + Ant 5	Max. Gain (dBi)	5.51	5.90	6.31	6.10	6.12	5.32	4.59	4.95	4.49
	Polarization	Theta	Theta	Theta	Theta	Theta	Phi	Theta	Theta	Theta
	Axis: Theta(°)	90	90	90	90	90	30	90	90	90
	Axis: Phi(°)	0	60	0	60	60	285	195	195	60
Ant 3 + Ant 6	Max. Gain (dBi)	5.46	6.08	7.15	7.30	6.25	5.40	5.13	5.98	5.20
	Polarization	Theta	Theta	Theta	Theta	Theta	Theta	Theta	Theta	Theta
	Axis: Theta(°)	90	60	90	90	90	75	105	105	90
	Axis: Phi(°)	345	165	345	345	345	210	315	315	315
Ant 4 + Ant 5	Max. Gain (dBi)	6.80	6.54	7.44	7.00	6.63	6.65	6.46	6.94	7.30
	Polarization	Theta	Theta	Theta	Theta	Theta	Phi	Phi	Phi	Phi
	Axis: Theta(°)	105	90	90	90	90	30	30	30	15
	Axis: Phi(°)	0	0	0	0	0	330	330	330	330
Ant 4 + Ant 6	Max. Gain (dBi)	6.38	5.75	6.10	6.31	6.07	6.24	5.83	5.87	5.26
	Polarization	Theta	Theta	Theta	Theta	Theta	Theta	Theta	Theta	Theta
	Axis: Theta(°)	105	75	90	90	75	90	90	90	90
	Axis: Phi(°)	150	165	30	30	165	30	315	315	315

Individual Antenna gain corresponds to directional gain										
Frequency (MHz)		5925	6175	6425	6475	6525	6695	6875	6995	7115
Ant 3 (dBi)		0.08	1.18	2.91	2.24	1.83	2.02	1.85	2.29	1.79
Ant 5 (dBi)		4.39	4.31	3.67	3.87	4.23	2.59	1.29	1.57	1.16
Polarization		Theta	Theta	Theta	Theta	Theta	Phi	Theta	Theta	Theta
Axis: Theta(°)		90	90	90	90	90	30	90	90	90
Axis: Phi(°)		0	60	0	60	60	285	195	195	60
Ant 3 (dBi)		0.62	3.61	2.82	3.22	1.76	3.06	1.81	3.95	-0.33
Ant 6 (dBi)		3.96	2.49	5.28	5.25	4.51	1.66	2.43	1.86	4.14
Polarization		Theta	Theta	Theta	Theta	Theta	Theta	Theta	Theta	Theta
Axis: Theta(°)		90	60	90	90	90	75	105	105	90
Axis: Phi(°)		345	165	345	345	345	210	315	315	315
Ant 4 (dBi)		4.31	4.36	5.14	5.28	4.42	4.67	4.38	4.95	3.06
Ant 5 (dBi)		3.22	2.61	3.67	2.49	2.73	2.48	2.40	2.76	5.37
Polarization		Theta	Theta	Theta	Theta	Theta	Phi	Phi	Phi	Phi
Axis: Theta(°)		105	90	90	90	90	30	30	30	15
Axis: Phi(°)		0	0	0	0	0	330	330	330	330
Ant 4 (dBi)		2.68	2.72	2.64	3.04	3.45	4.37	0.67	0.87	-0.17
Ant 6 (dBi)		4.01	2.75	3.52	3.56	2.66	1.92	4.54	4.48	4.14
Polarization		Theta	Theta	Theta	Theta	Theta	Theta	Theta	Theta	Theta
Axis: Theta(°)		105	75	90	90	75	90	90	90	90
Axis: Phi(°)		150	165	30	30	165	30	315	315	315

Directional Gain Result - 2D Radiation Pattern

- ◆ Refer to the attached file: Directional Gain Result - 2D Radiation Pattern

