Comcast XB10 Antenna Sercomm ID Passive Antenna Report DVT 2

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Date: 10th October 2024

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Introduction

Introduction

- **This report presents the passive antenna performance for XB10**
- **Airgain built and measured antennas in a DVT2 unit**
- **Airgain printed an antenna carrier based on a reported placement of antennas**
- **Airgain Integrated 10 antennas into the simulation mockup**
  - 4 WiFi DB antennas (2.4-2.5GHz and 5.15-5.85GHz band of operation)
  - 4 WiFi 6E antennas (5.925-7.125GHz Band of operation)
  - 2 IOT Antenna (Zigbee)
- **Sercomm Integrated 1 BT antenna into the simulation mockup**
  - 1 BT antenna (2.4-2.5GHz band of operation)
  - The test result of BT antenna present in the back of this report.
- **Cable losses are included in the measurement data**

Antenna List

No	PN	Cable length (mm)	Cable type	Connector	Frequency Coverage
ANT 1	N06CTANG-PK1-LB1X80BU Rev F	80	1.37mm Low Loss Coaxial Cable	U.FL	WiFi 6GHz
ANT 2	N06CTANH-PK1-LP1X135BU Rev G	135	1.37mm Low Loss Coaxial Cable	U.FL	WiFi 6GHz
ANT 3	N06CTANE-PK1-LG1X180BU Rev G	180	1.37mm Low Loss Coaxial Cable	U.FL	WiFi 6GHz
ANT 4	N06CTANF-PK1-LW1X125BU Rev F	125	1.37mm Low Loss Coaxial Cable	U.FL	WiFi 6GHz
ANT 5	N03CTAND-PK1-Y1X205BU Rev E	205	1.37mm Coaxial Cable	U.FL	WiFi-2.4GHz and WiFi-5GHz
ANT 6	N03CTANR-PK1-B1X150BU Rev A	150	1.37mm Coaxial Cable	U.FL	WiFi-2.4GHz and WiFi-5GHz
ANT 7	N03CTANS-PK1-A1X240BU Rev B	240	1.37mm Coaxial Cable	U.FL	WiFi-2.4GHz and WiFi-5GHz
ANT 8	N03CTANA-PK1-R1X215BU Rev E	215	1.37mm Coaxial Cable	U.FL	WiFi-2.4GHz and WiFi-5GHz
ANT 9	N01CTANJ-PK1-B1X230BU Rev F	230	1.37mm Coaxial Cable	U.FL	Zigbee IOT 2.4GHz
ANT 10	N01CTANK-PK1-Q1X245BU Rev G	245	1.37mm Coaxial Cable	U.FL	Zigbee IOT 2.4GHz

Airgain Antenna Measurement System

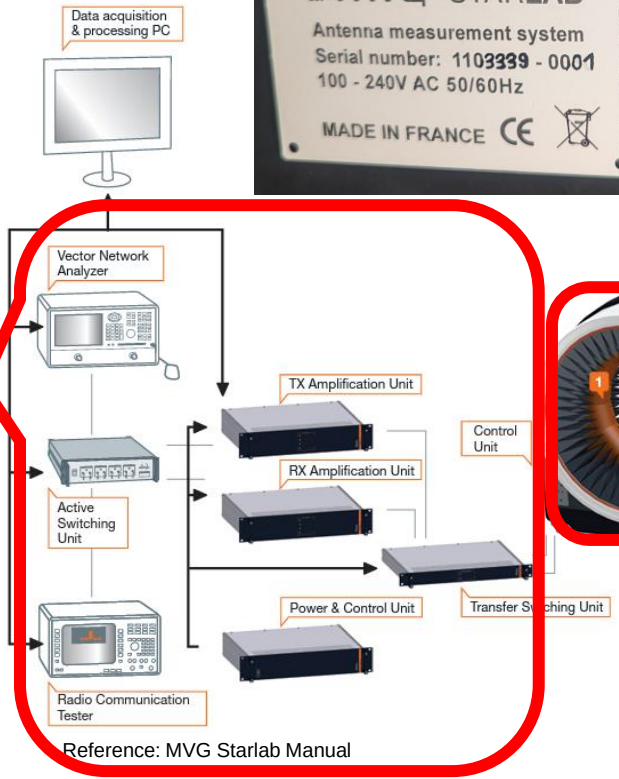
Test Information

Item	Description
Chamber Brand Name	Comcast
Equipment	XB10
Test Location	7860 E. McClain Dr., Suite #2Scottsdale, AZ 85260
Test Condition	Radiation
Test Engineer	Delroy
Test Environment	MVG STARLAB
Test Date	October 10th, 2024
Measurement control	Wavestudio - 24.2.8
Near/Far field transform	MV-Sphere - 3.4.4 GIT-5CFE3A096
OTA measurement suite	Sat Env – Version 3.0.3.0 Built 23

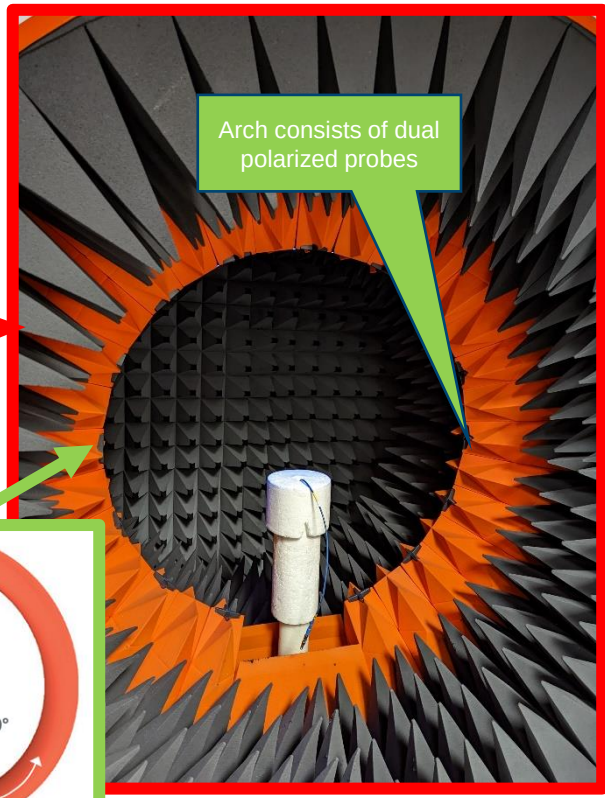
Test Equipment and Calibration

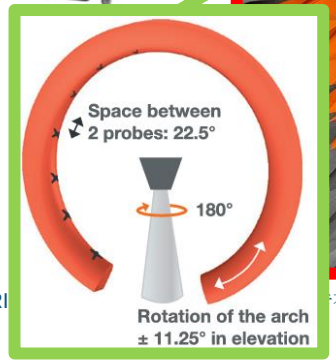
Instrument	Brand	Characteristics	Model No	Serial No	Calibration Due
Anechoic Chamber	MVG	600MHz-8GHz	Star Lab	1103339-0001	November 2024
VNA	Keysight	100kHz-8.5GHz	E5063A	MY54101021	September 2025

Measurement setup Architecture



Reference: MVG Starlab Manual





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Measurement setup Architecture for Passive Near-Field measurement

- Starlab uses an Active Switching Unit to switch between near-field passive measurement and OTA measurement
- For near-field passive measurement a Vector Network analyzer is used as RF source/receiver
- The power and control unit supplies the power and driver the RF units on the arch
- Starlab performs a over sampling by mechanically rotating the arch by ±11.25° in elevation
- The software translates the measured near-field into far-field
- All the AUT/DUT are measured with phase center located in the quite zone of the chamber for calibration, Validation and performance evaluation
- Starlab can accommodate AUT/DUT up to 45 cm in diameter

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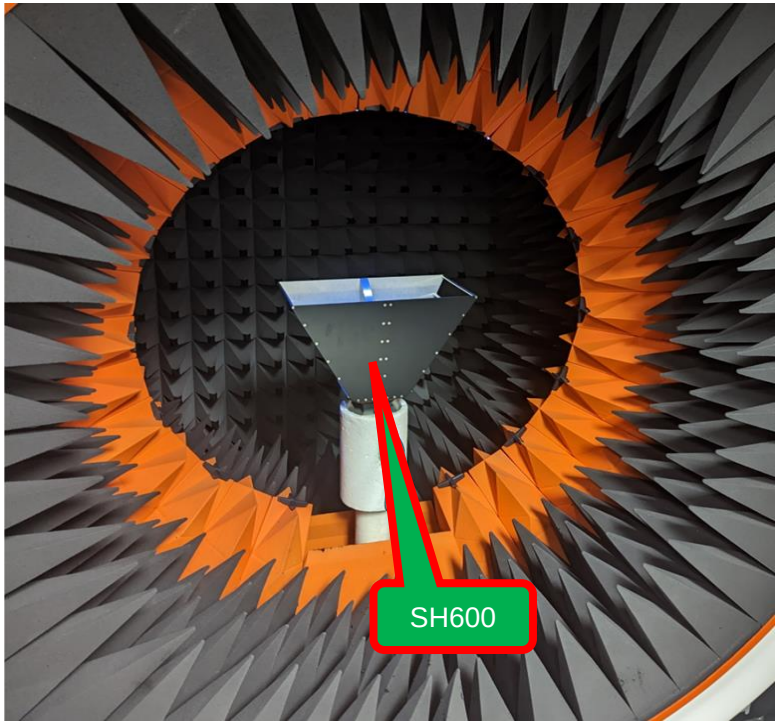
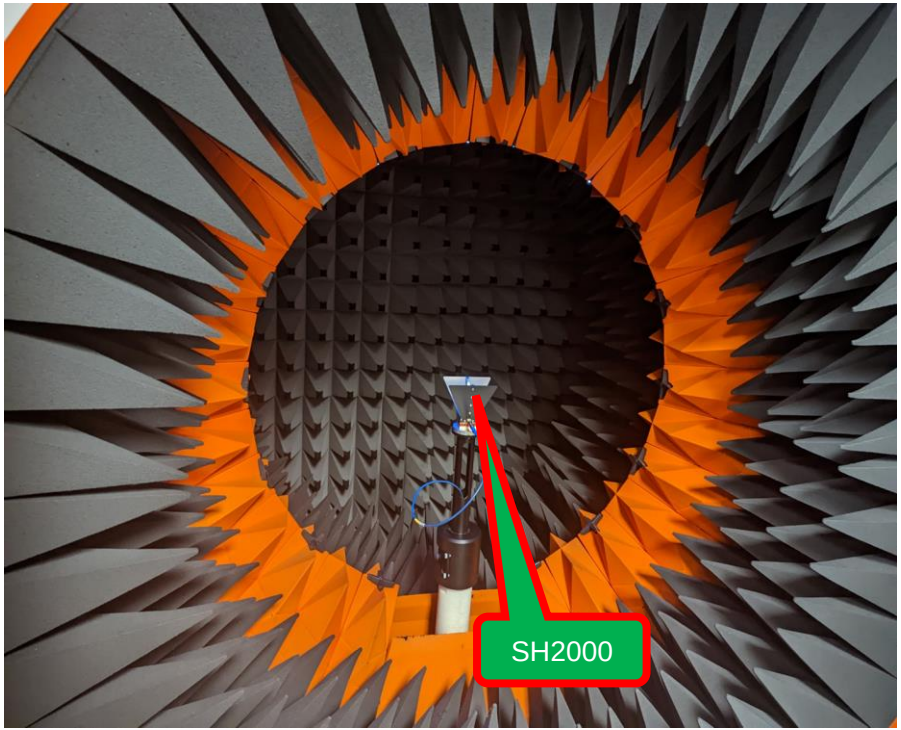
Passive Antenna Calibration Setup

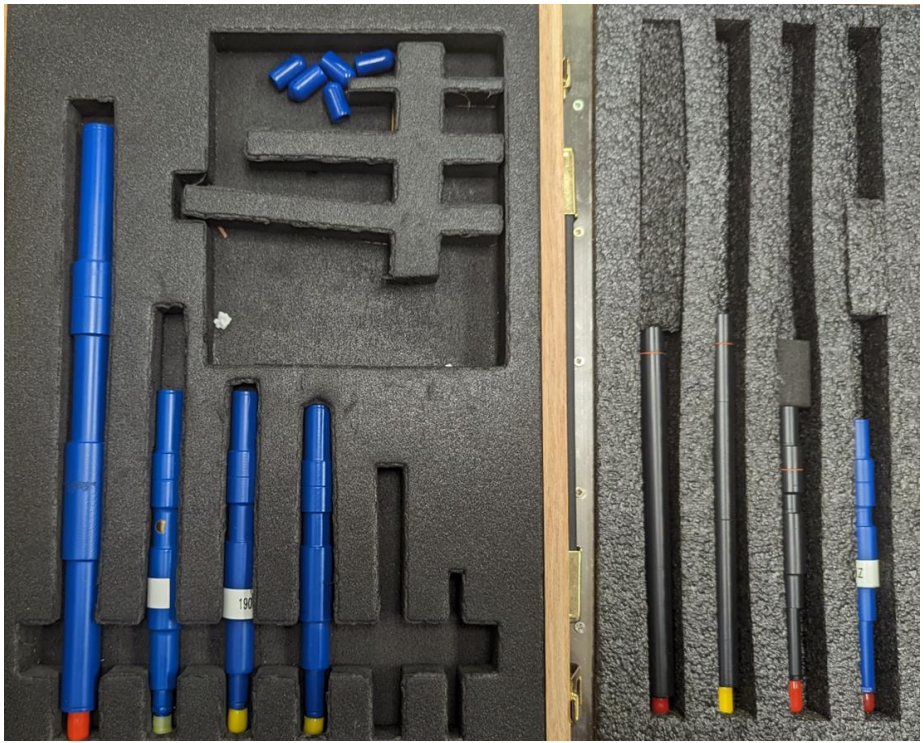




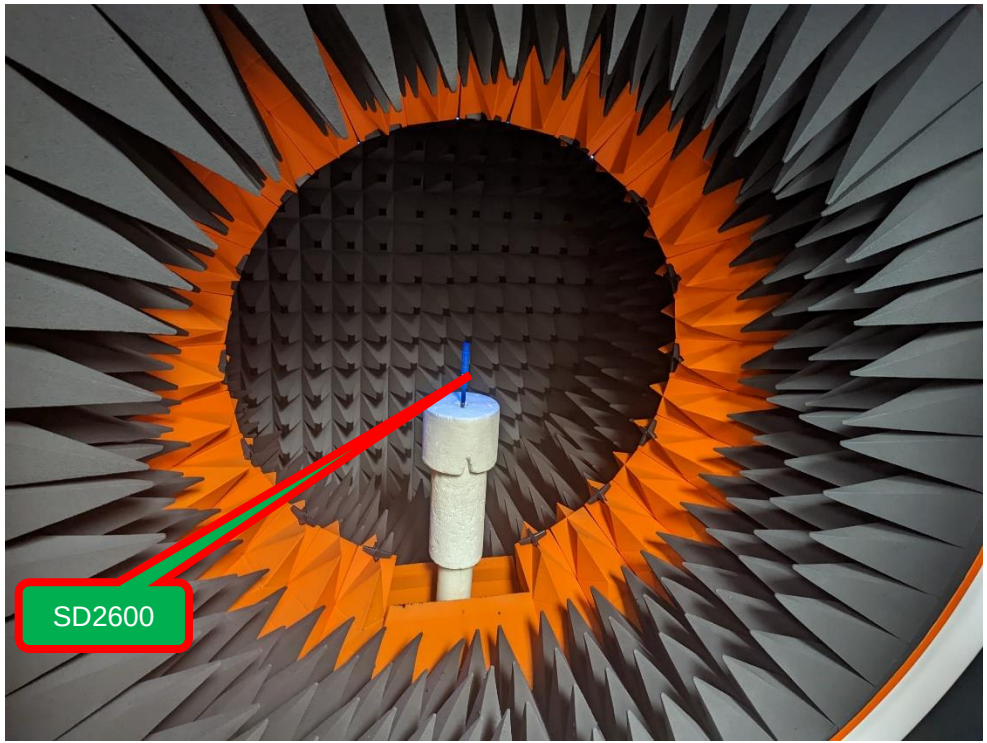
Passive Antenna Calibration (Gain Substitution Mehod)

- Starlab is calibrated on a monthly basis by using MVG calibration method
- A standard Satimo horn antenna SH600 and SH2000 are used for calibrating the changer in low and high frequency bands of operation
- The horn antennas are measured in the chamber and the calibration is performed in post processing with reference to standard gain values of the horn which are certified and provided by MVG
- During postposing a ***gain substitution*** method is used and the measured gain/efficiency data is computed against the standard gain/efficiency values of the horn antenna and a new calibration file is generated
- The calibrated file generated is stored as a new primary calibration file which will be recalled automatically during post processing of any AUT/DUT measurements

Passive Antenna Validation Dipoles



Passive Antenna Validation Setup



Passive Antenna Validation

- Starlab is validated after the calibration process is completed, and a routine validation is performed every week to ensure the calibration has not been drifted over the time.
- Standard Satimo dipoles are measured in different frequency range based upon the dipole specs.
- Standard dipole include SD900, SD1800, SD1900, SD1900, SD2050, SD2450, SD2600, SD5150, SD5650
- Dipoles are measured and post processed with standard AUT/DUT measurement steps
- Upon postprocessing the output gain and efficiency of the dipole is compared to the standard dipole data provided and certified by MVG/Satimo
- If the measured values are out of limit a new calibration is performed if needed

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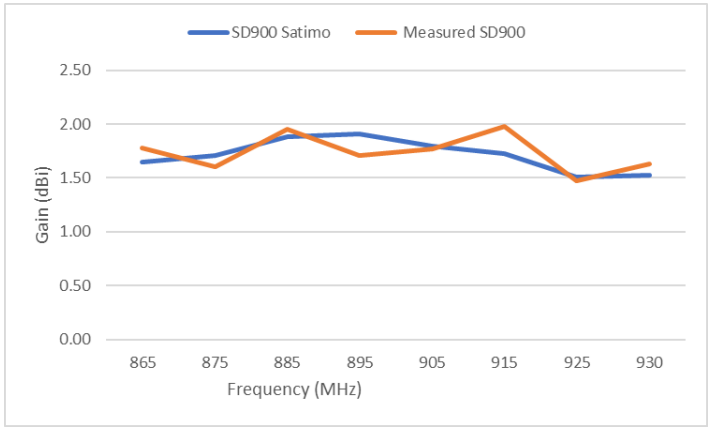
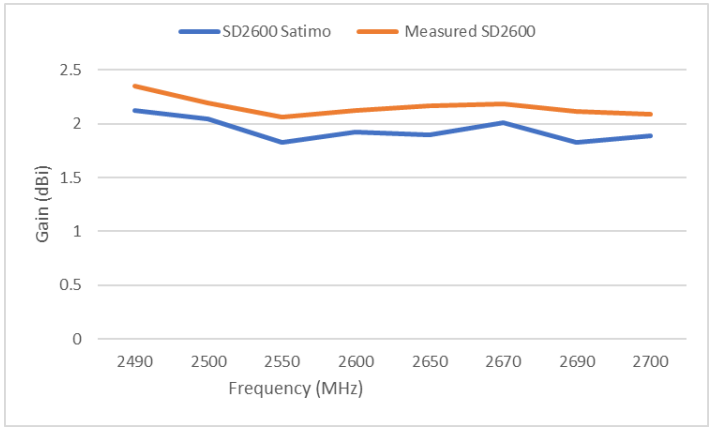
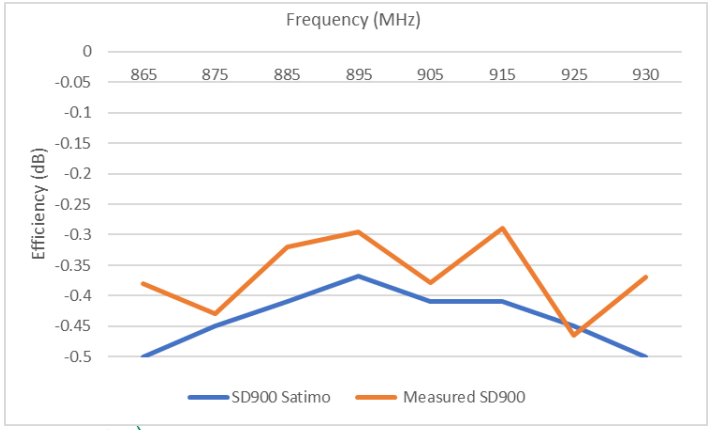
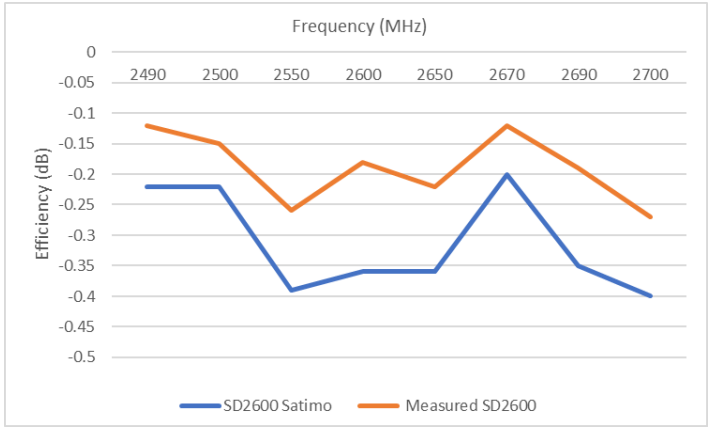
Passive Antenna Validation Results









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Chamber stability certified by MVG

- MVG visits on site every year and performs a full set of system calibration which is valid for a year
- During the calibration and validation process MVG checks the performance of the full system and ensures the measured/validated data is in the tolerance limit of Starlab specs

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MVG Chamber Validations/ Calibrations Data

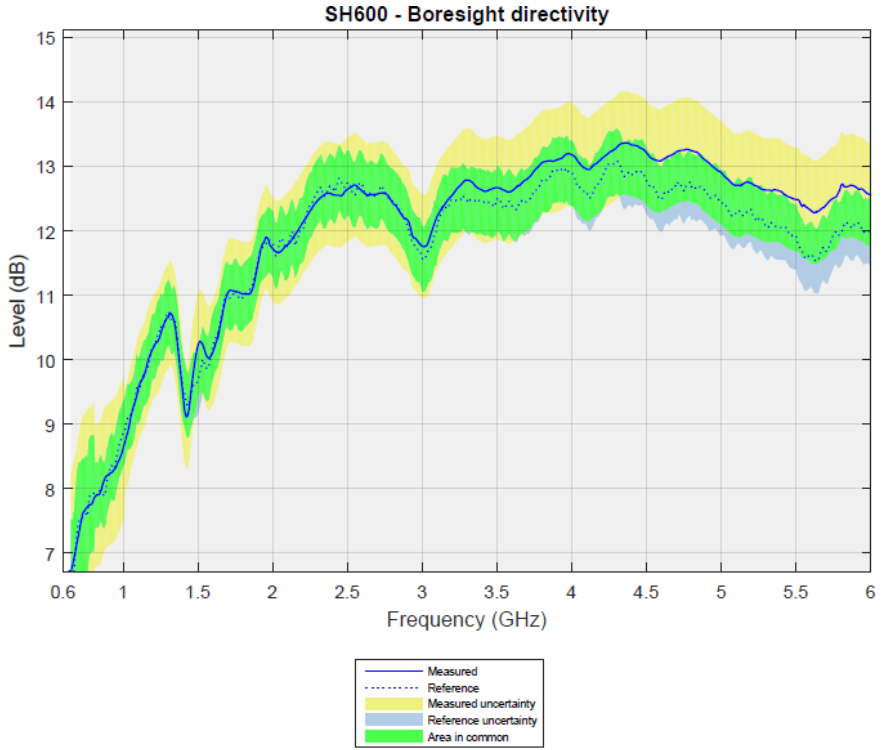


Figure 5.1: Boresight directivity

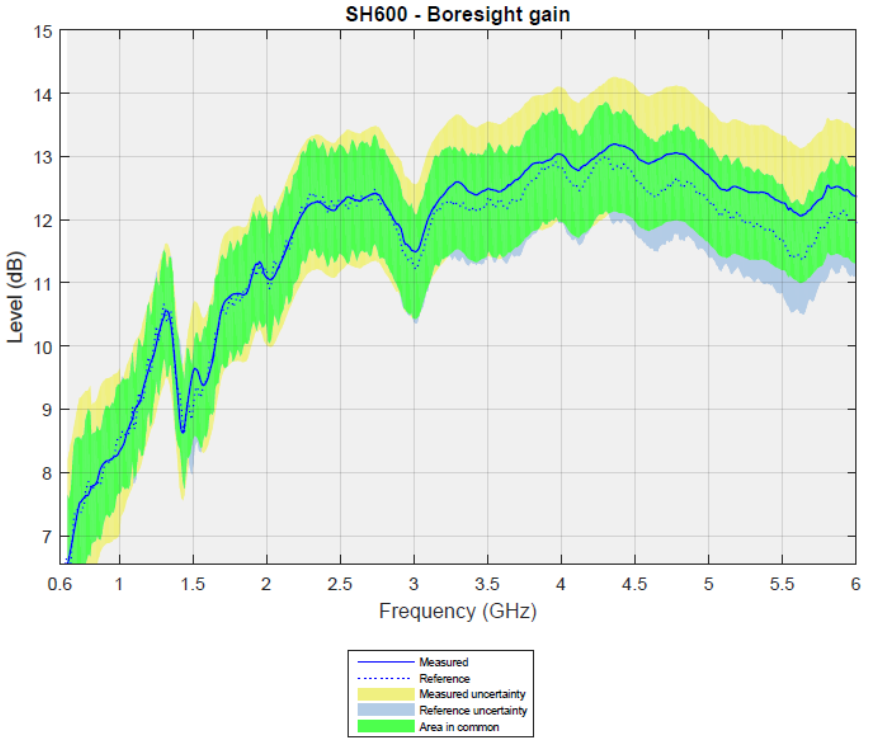


Figure 5.2: Boresight gain

MVG Chamber Validations/ Calibrations Data

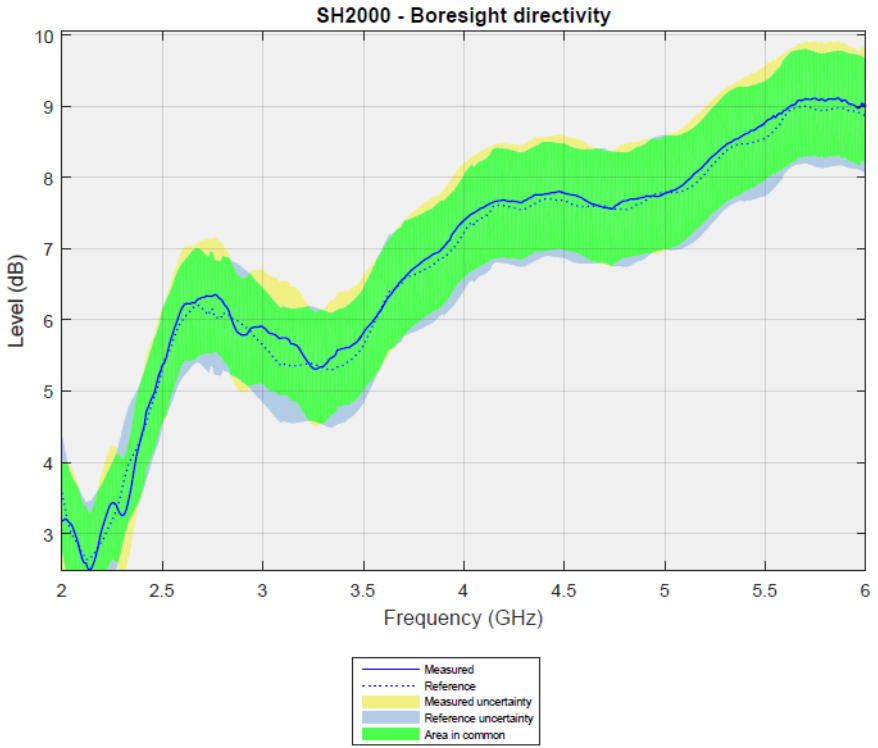


Figure 5.60: Boresight directivity

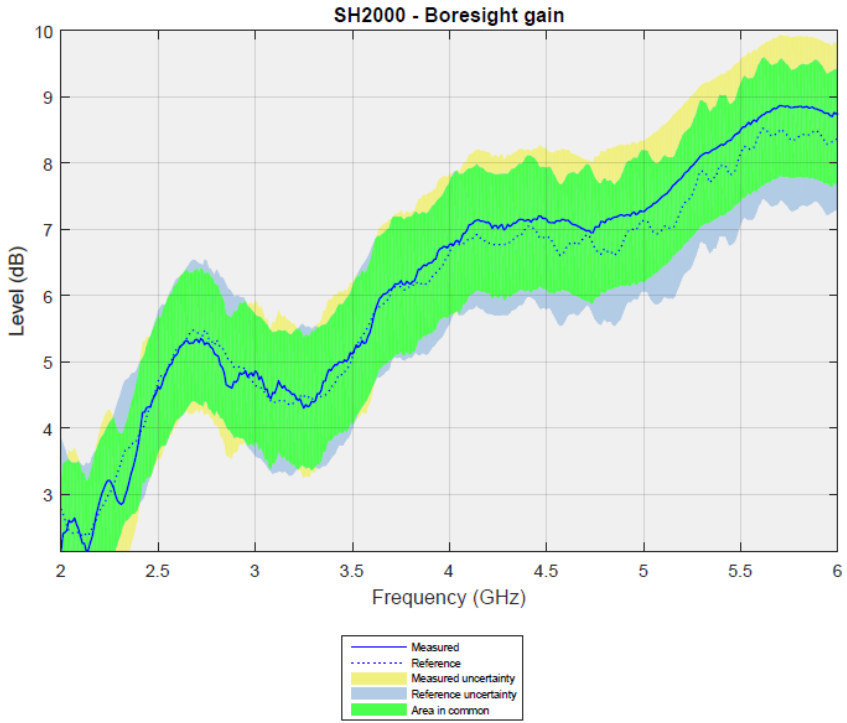


Figure 5.61: Boresight gain

MVG Chamber Validations/ Calibrations Data

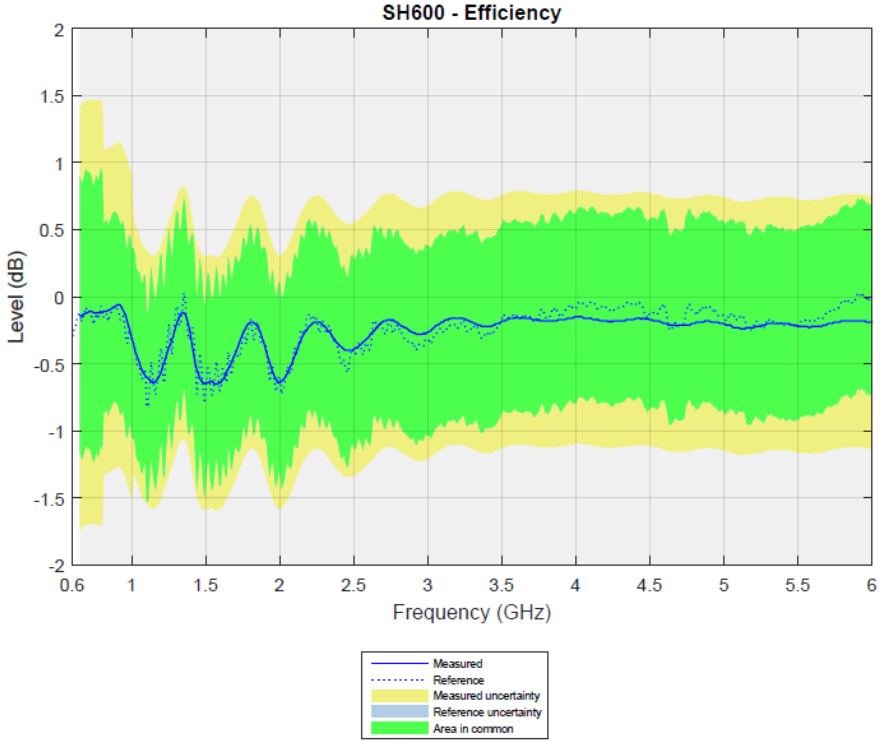


Figure 5.3: Efficiency

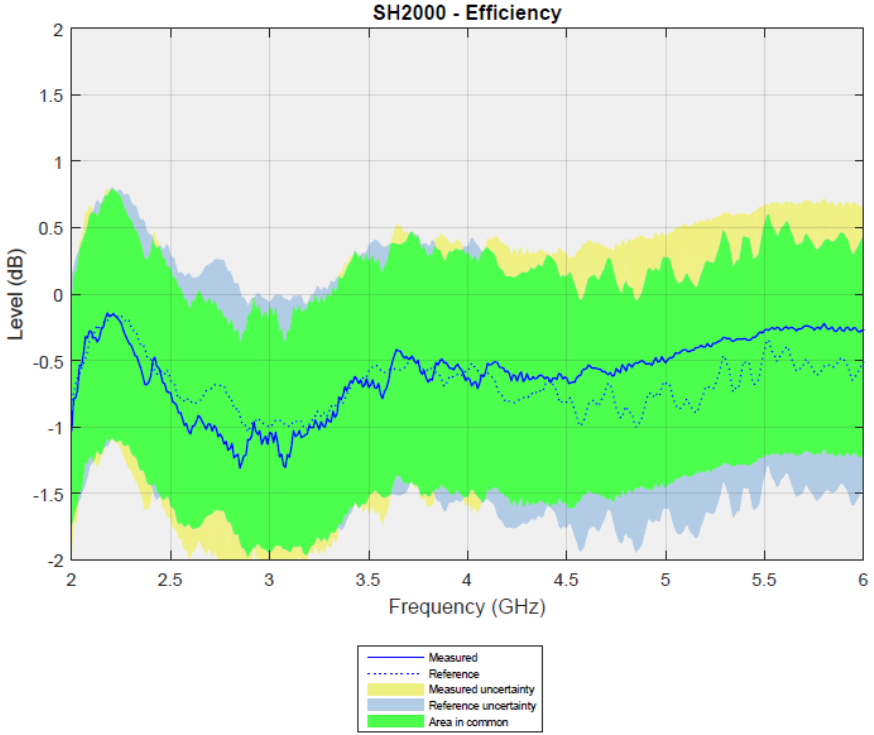
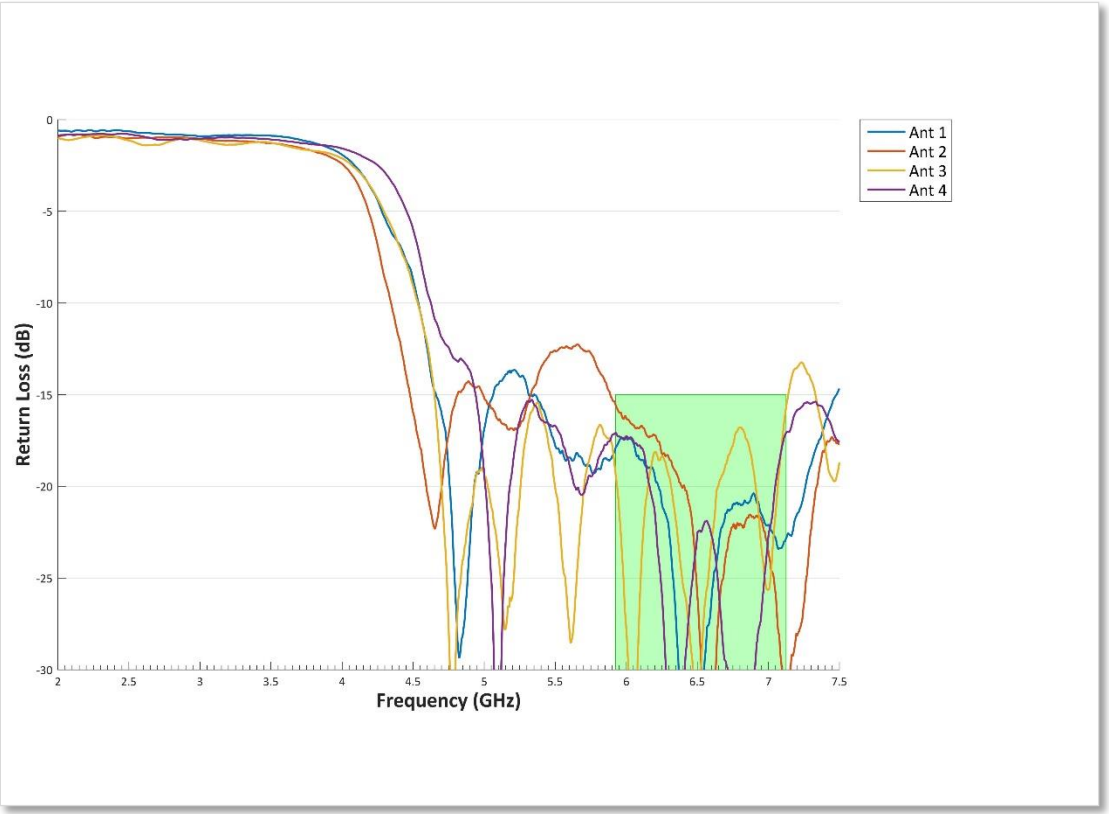


Figure 5.62: Efficiency

S-Parameters

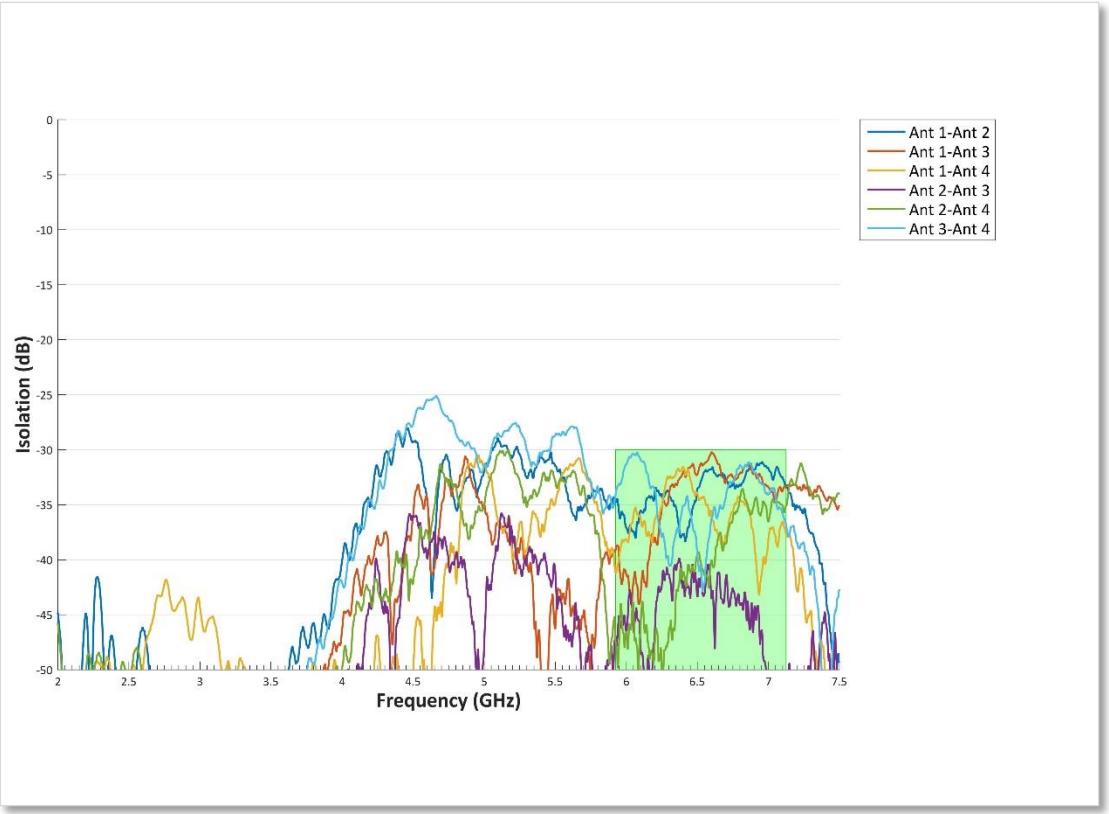
S-Parameter – Return Loss for Wi-Fi 6GHz Antennas



KEY OBSERVATIONS

Antenna	Return Loss (dB)	
	5.925 GHz	7.125 GHz
Ant 1	-17.9	-22.8
Ant 2	-15.5	-32.4
Ant 3	-19.3	-15.6
Ant 4	-17.1	-17.1

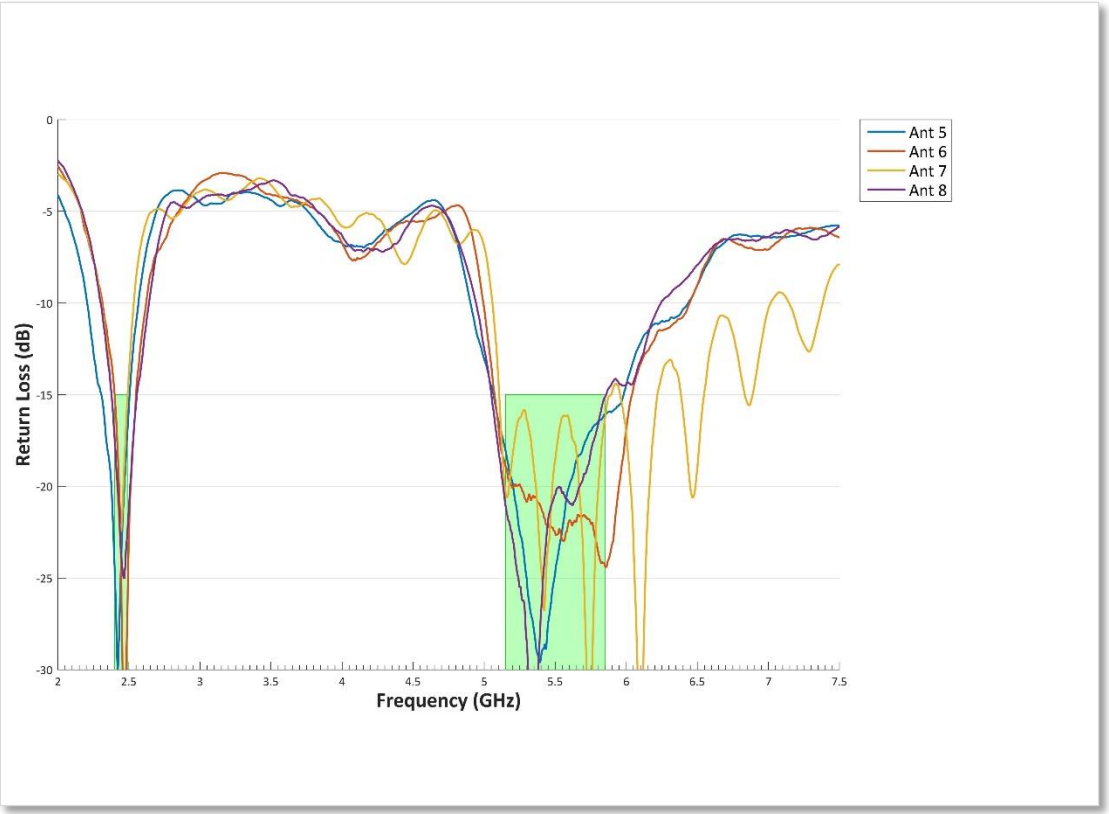
S-Parameter – Isolation for Wi-Fi 6GHz Antennas



KEY OBSERVATIONS

Antenna	Minimum Isolation (dB)
	5.925 - 7.125 GHz
Ant 1-Ant 2	-31.5
Ant 1-Ant 3	-31.2
Ant 1-Ant 4	-31.5
Ant 2-Ant 3	-39.8
Ant 2-Ant 4	-33.6
Ant 3-Ant 4	-30.3

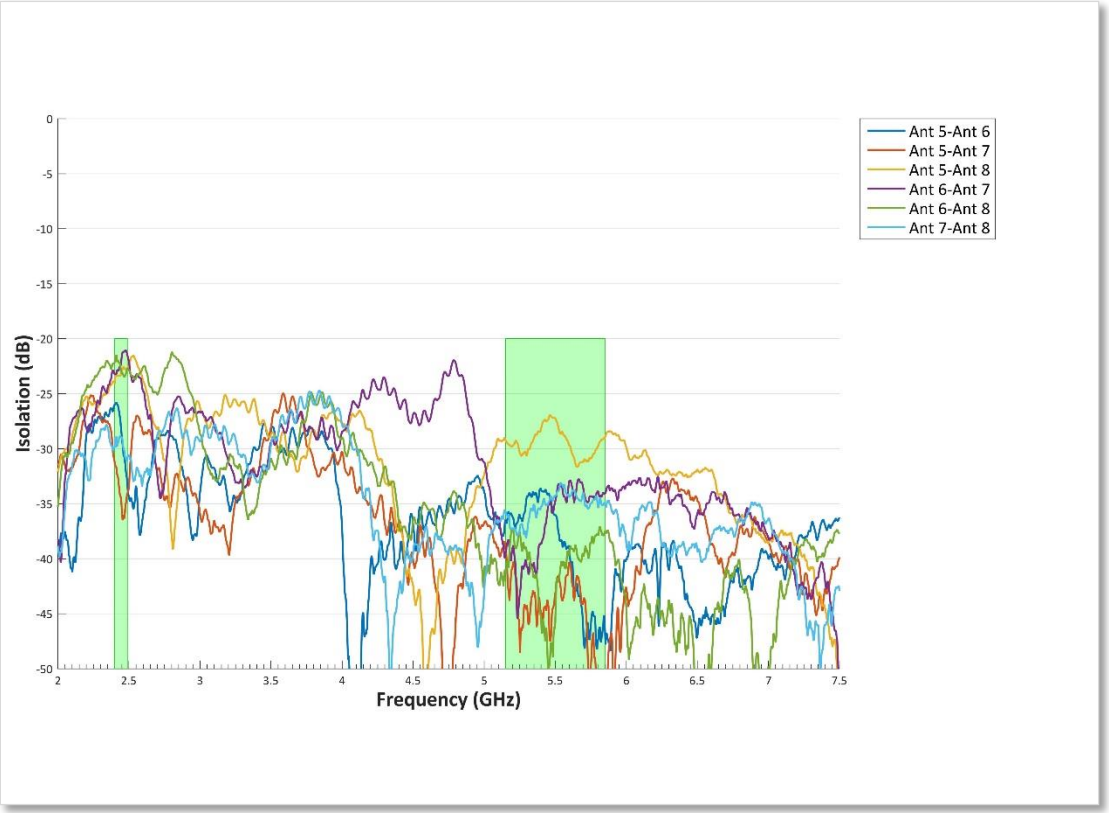
S-Parameter – Return Loss for Wi-Fi Dual band Antennas



KEY OBSERVATIONS

Antenna	Return Loss (dB)			
	2.4 GHz	2.49 GHz	5.15 GHz	5.85 GHz
Ant 5	-24.6	-16.9	-18.0	-16.1
Ant 6	-15.1	-26.4	-18.9	-24.4
Ant 7	-17.2	-15	-20.3	-16.3
Ant 8	-17.5	-22.3	-21.1	-15.1

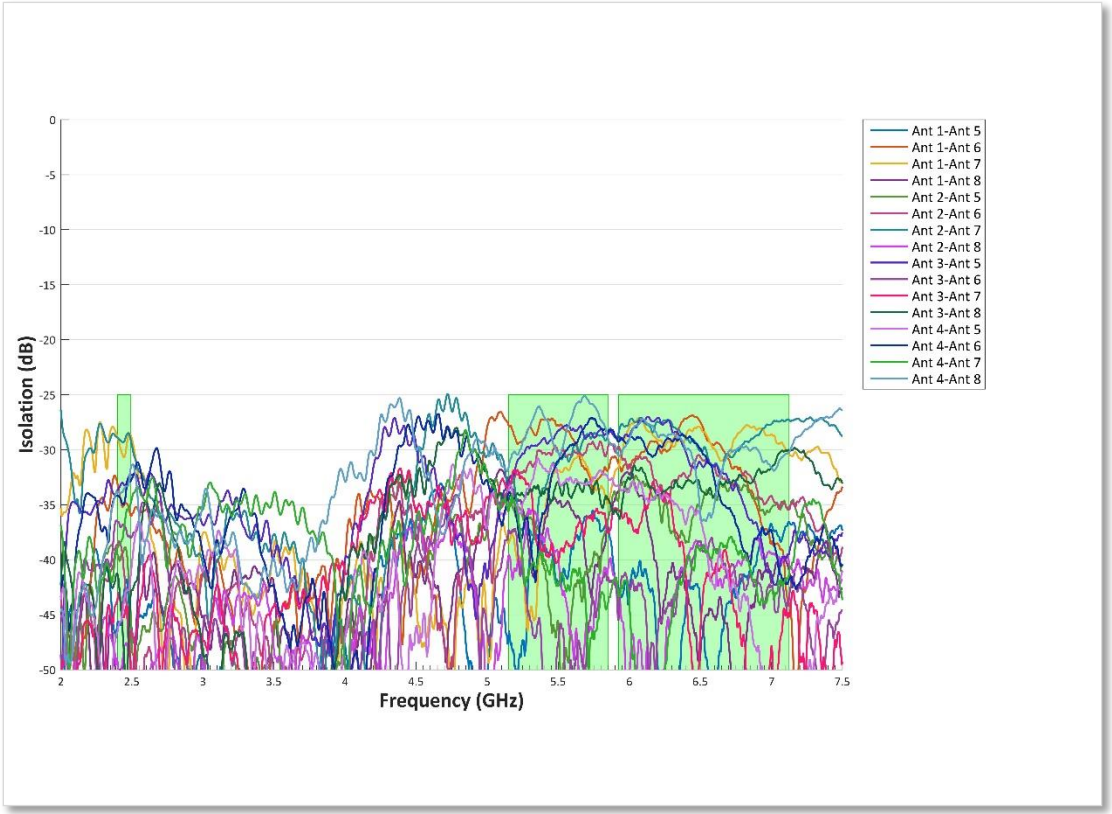
S-Parameter – Isolation for Wi-Fi Dual band Antennas



KEY OBSERVATIONS

Antenna	Minimum Isolation (dB)	
	2.4-2.49 GHz	5.15-5.85 GHz
Ant 5-Ant 6	-25.8	-33.6
Ant 5-Ant 7	-31.3	-38.4
Ant 5-Ant 8	-22.5	-27
Ant 6-Ant 7	-21.8	-32.8
Ant 6-Ant 8	-21.5	-37.1
Ant 7-Ant 8	-28.8	-33.1

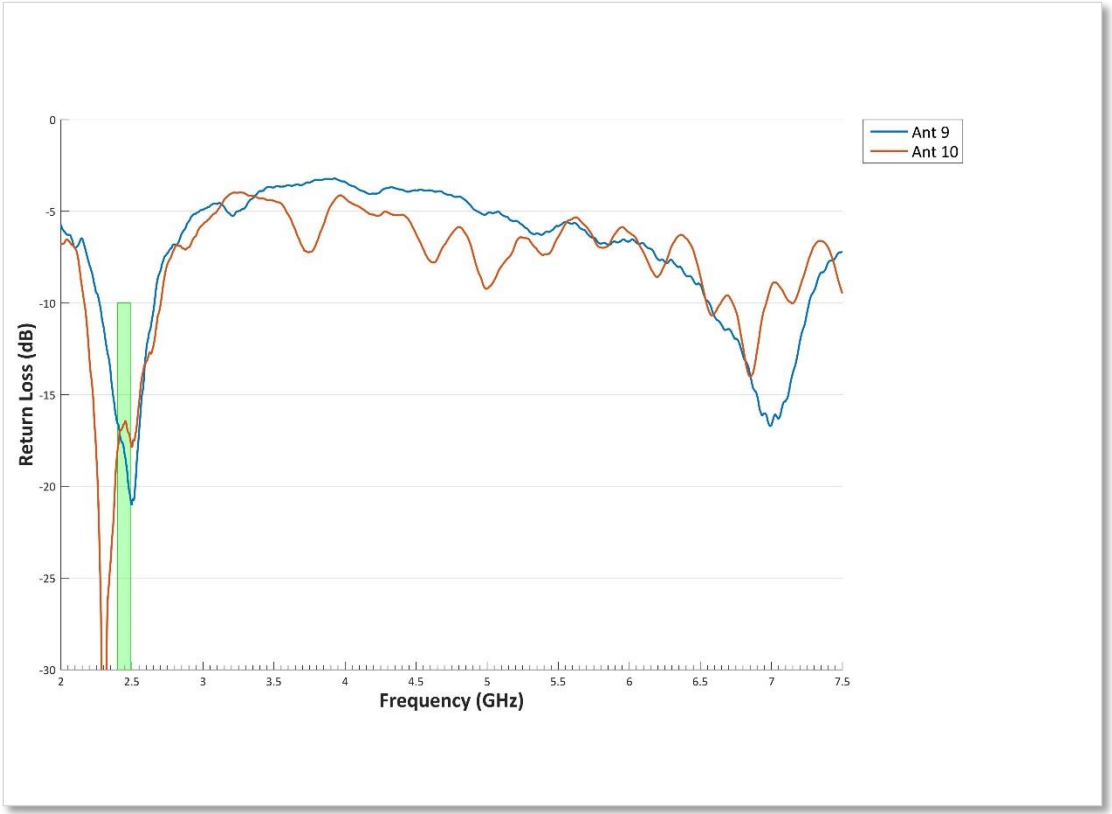
S-Parameter – Isolation Between Dual Band and 6GHz Antennas



KEY OBSERVATIONS

Antenna	Minimum Isolation (dB)		
	2.4GHz band	5GHz Band	6GHz Band
Ant 1-Ant 5	-41.8	-35.5	-36.5
Ant 1-Ant 6	-33.2	-27.1	-26.9
Ant 1-Ant 7	-28.6	-30.4	-27.1
Ant 1-Ant 8	-49.4	-32.8	-32
Ant 2-Ant 5	-38.9	-34.7	-32.4
Ant 2-Ant 6	-38.3	-29.2	-29.7
Ant 2-Ant 7	-28.5	-28.5	-27.1
Ant 2-Ant 8	-47.6	-35.3	-38
Ant 3-Ant 5	-32.3	-27.8	-27
Ant 3-Ant 6	-36.6	-37.1	-38
Ant 3-Ant 7	-43	-31.8	-32.9
Ant 3-Ant 8	-41.4	-32.6	-30
Ant 4-Ant 5	-41.5	-30.8	-32.8
Ant 4-Ant 6	-32.6	-27.1	-28.6
Ant 4-Ant 7	-34.9	-34	-37.9
Ant 4-Ant 8	-31.8	-25.9	-27.2

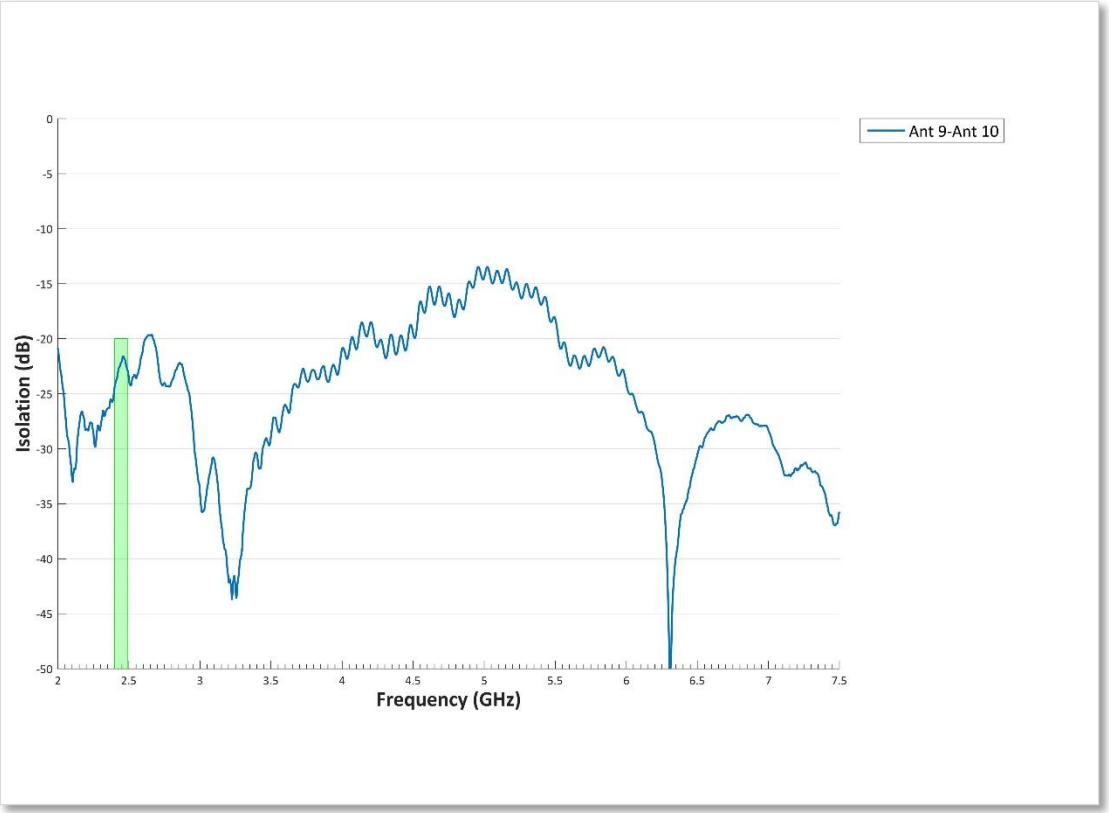
S-Parameter – Return Loss for Zigbee Antennas



KEY OBSERVATIONS

Antenna	Return Loss (dB)	
	2.4 GHz	2.49 GHz
Ant9	-16.6	-20.7
Ant10	-18	-17.6

S-Parameter – Isolation for Zigbee Antennas



KEY OBSERVATIONS

Antenna	Return Loss (dB)
	2.4 GHz - 2.49GHz
Ant9-Ant10	-21.6

Efficiency and Peak Gain

Antenna Efficiency (%) and Peak Gain(dBi) – 6GHz Wi-Fi Antennas

Frequency (MHz)	Ant1 (%)	Ant2 (%)	Ant3 (%)	Ant4 (%)
5925	70	71	67	68
6000	73	75	68	68
6100	72	76	68	67
6200	72	73	69	70
6300	70	71	70	69
6400	69	70	71	70
6500	68	69	72	73
6600	69	69	69	72
6700	70	70	70	71
6800	70	72	69	74
6900	73	73	68	73
7000	74	74	69	72
7100	74	73	70	70
7125	75	74	71	70
Average	71	72	69	71

Frequency (MHz)	Ant1 (dBi)	Ant2 (dBi)	Ant3 (dBi)	Ant4 (dBi)
5925	4.9	4.3	4.9	4.5
6000	4.9	4.7	4.9	4.7
6100	4.8	4.9	4.9	4.9
6200	5.0	4.8	4.9	4.9
6300	4.8	4.8	4.8	4.9
6400	4.7	4.9	4.8	4.9
6500	4.8	5.0	4.7	4.8
6600	4.9	4.8	5.0	4.8
6700	5.2	5.0	4.9	4.6
6800	4.8	4.8	4.8	4.6
6900	4.8	4.7	5.3	4.3
7000	4.7	4.8	5.1	4.8
7100	4.3	4.7	4.9	4.6
7125	4.6	4.9	4.8	4.7

Measurements Including the cable loss

Antenna Efficiency (%) and Peak Gain(dBi) – 2.4 GHz Wi-Fi Antennas

Frequency (MHz)	Ant5 (%)	Ant6 (%)	Ant7 (%)	Ant8 (%)
2400	73	76	68	74
2410	73	75	68	74
2420	75	75	69	73
2430	75	76	69	74
2440	76	74	71	72
2450	76	75	72	73
2460	76	76	72	70
2470	75	76	72	70
2480	74	77	70	71
2490	74	75	70	69
Average	75	76	70	72

Frequency (MHz)	Ant5 (dBi)	Ant6 (dBi)	Ant7 (dBi)	Ant8 (dBi)
2400	4.7	4.5	4.7	4.6
2410	4.8	4.4	4.5	4.4
2420	4.7	4.6	4.2	4.4
2430	4.8	4.8	4.7	4.5
2440	4.7	4.8	4.6	4.3
2450	4.5	4.7	4.7	4.1
2460	4.6	4.6	5.1	4.1
2470	4.6	4.7	4.4	4.1
2480	4.6	4.8	4.5	4.1
2490	4.5	4.7	4.7	4.2

Measurements Including the cable loss

Antenna Efficiency (%) and Peak Gain(dBi) – 5 GHz Wi-Fi Antennas

Frequency (MHz)	Ant5 (%)	Ant6 (%)	Ant7 (%)	Ant8 (%)
5150	70	71	68	70
5200	69	72	69	71
5300	72	73	68	69
5400	71	73	70	69
5500	70	72	71	68
5600	69	71	70	70
5700	69	71	71	72
5800	70	69	70	74
5850	70	72	73	74
Average	70	72	70	71

Frequency (MHz)	Ant5 (dBi)	Ant6 (dBi)	Ant7 (dBi)	Ant8 (dBi)
5150	4.8	4.9	4.7	5.0
5200	4.7	5.0	4.7	4.9
5300	4.7	4.6	4.7	4.9
5400	4.6	4.8	4.9	4.9
5500	4.8	4.9	4.7	4.8
5600	4.7	5.0	4.6	4.9
5700	4.6	4.8	4.5	4.6
5850	5.0	4.8	4.3	4.5

Measurements Including the cable loss

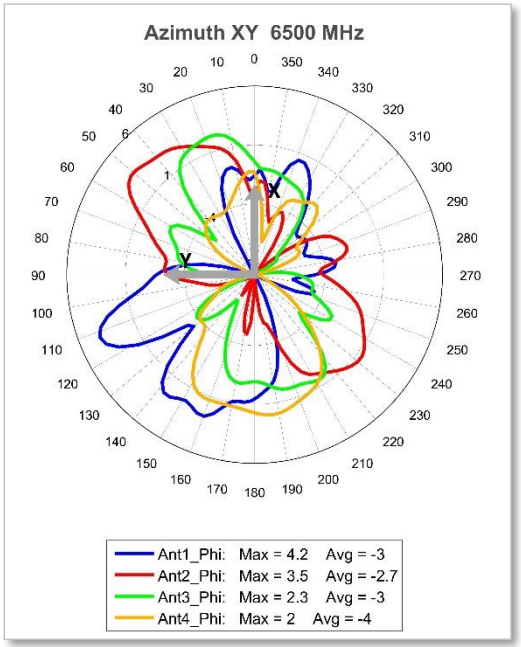
Antenna Efficiency (%) and Peak Gain(dBi) Zigbee Antenna

Frequency (MHz)	Ant9 (%)	Ant10 (%)
2400	72	67
2410	72	66
2420	73	67
2430	74	68
2440	72	68
2450	73	68
2460	75	68
2470	75	69
2480	74	69
2490	73	69
Average	73	68

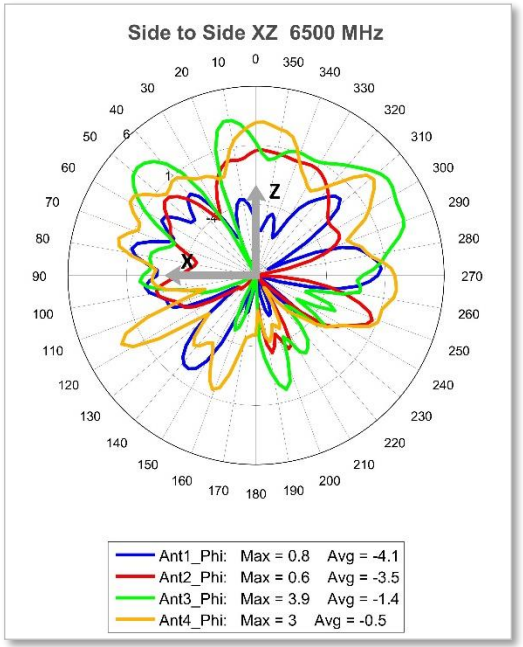
Frequency (MHz)	Ant9 (dBi)	Ant10 (dBi)
2400	4.6	4.3
2410	4.6	4.4
2420	4.6	4.4
2430	4.7	4.6
2440	4.6	4.7
2450	4.5	4.6
2460	4.6	4.7
2470	4.7	4.6
2480	4.6	4.6
2490	4.6	4.6

Antenna Radiation Patterns
System 2D Cuts

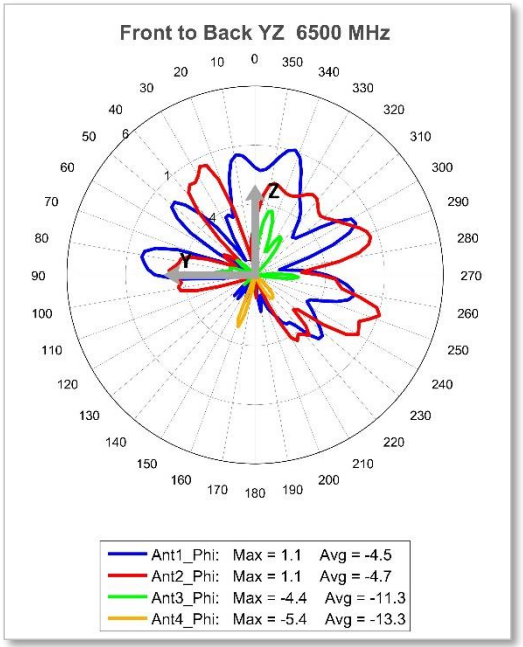
Wi-Fi Ant1-Ant4 2D Cut at 6.5GHz -Phi



Azimuth (XY)

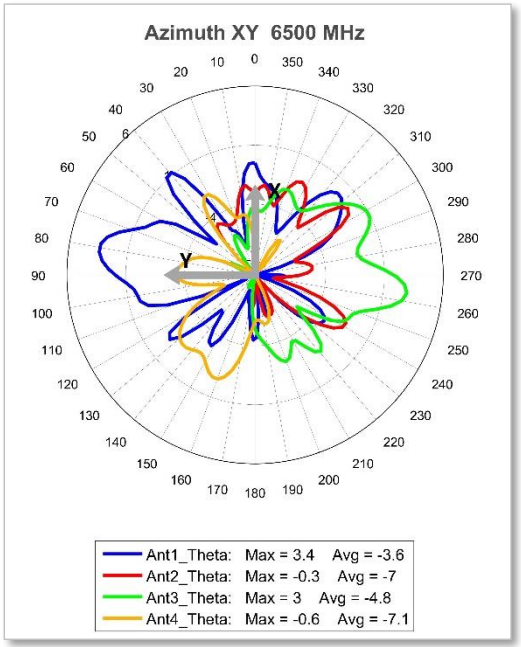


Side to Side (XZ)

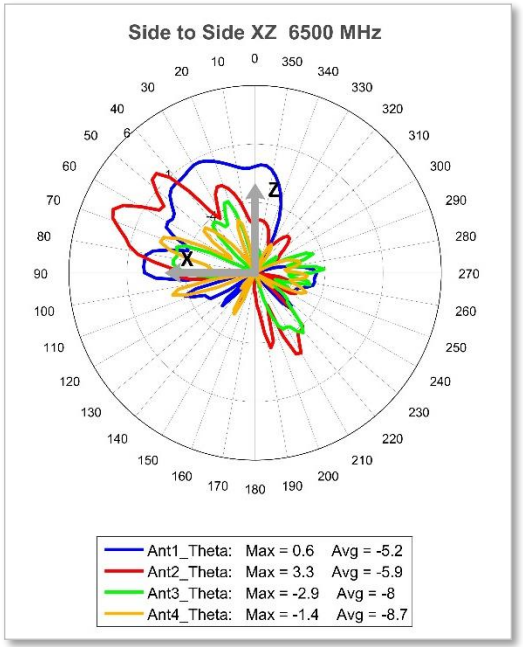


Front to Back (YZ)

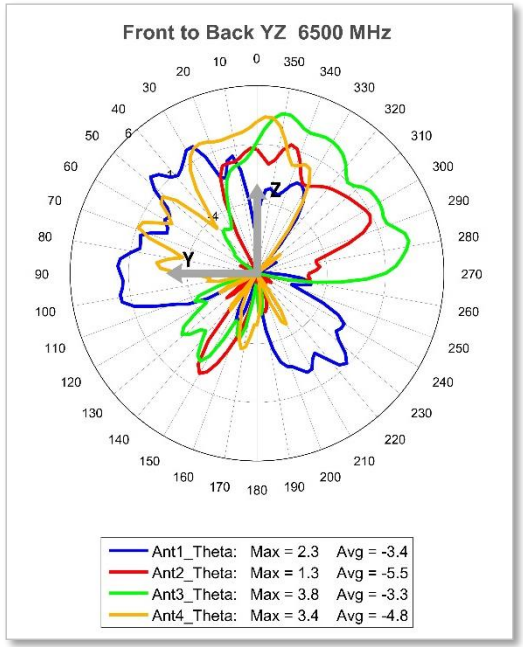
Wi-Fi Ant1-Ant4 2D Cut at 6.5GHz -Theta



Azimuth (XY)

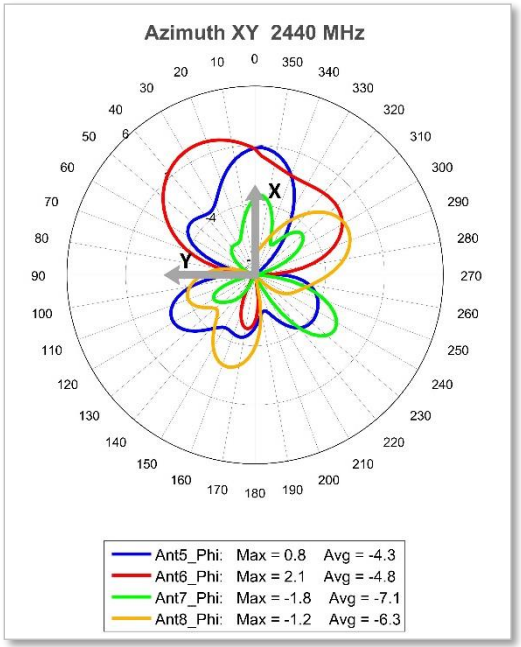


Side to Side (XZ)

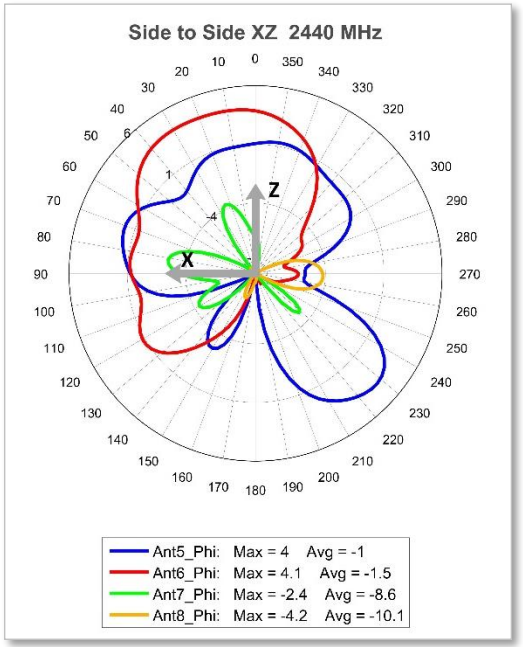


Front to Back (YZ)

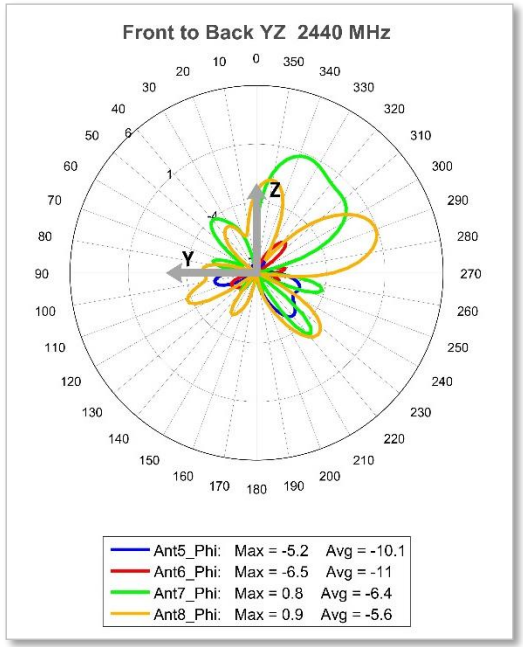
Wi-Fi Ant5-Ant8 2D Cut at 2.44GHz -Phi



Azimuth (XY)

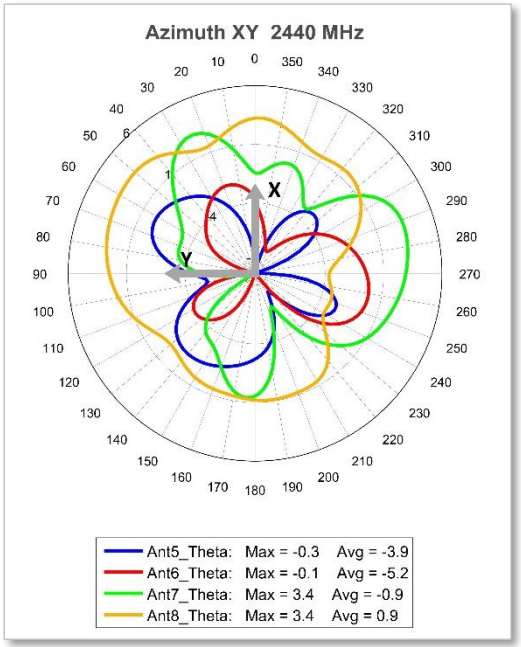


Side to Side (XZ)

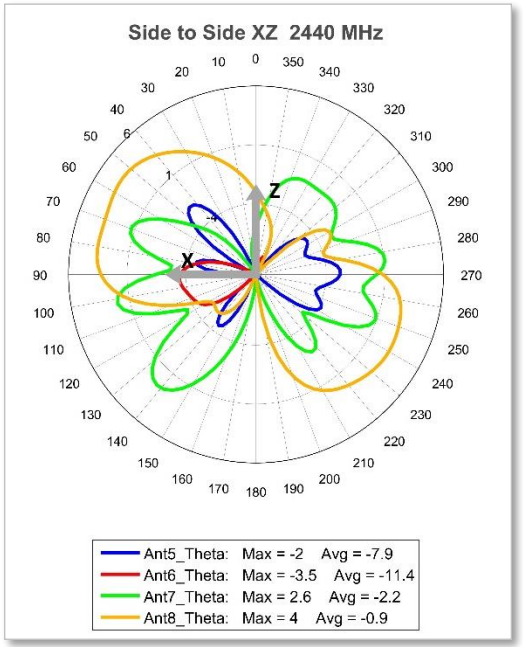


Front to Back (YZ)

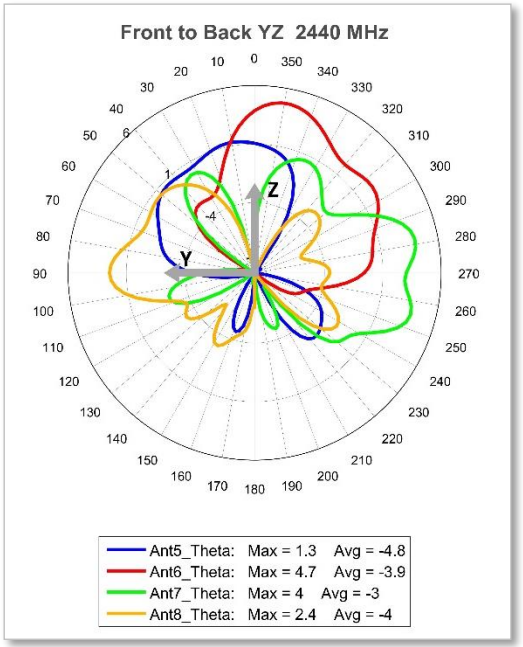
Wi-Fi Ant5-Ant8 2D Cut at 2.44GHz -Theta



Azimuth (XY)

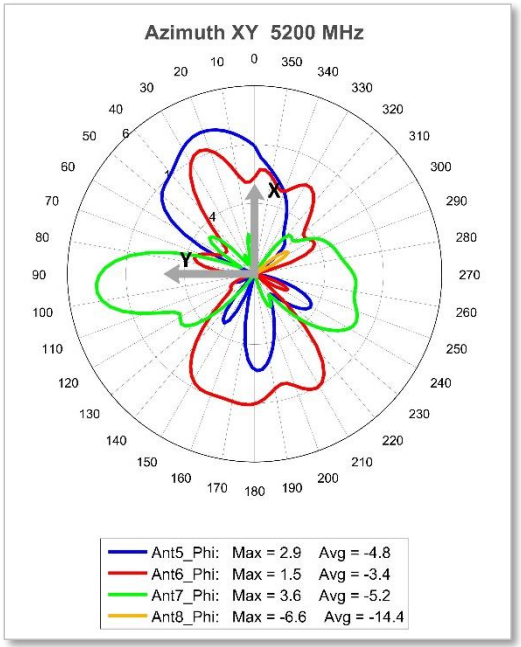


Side to Side (XZ)

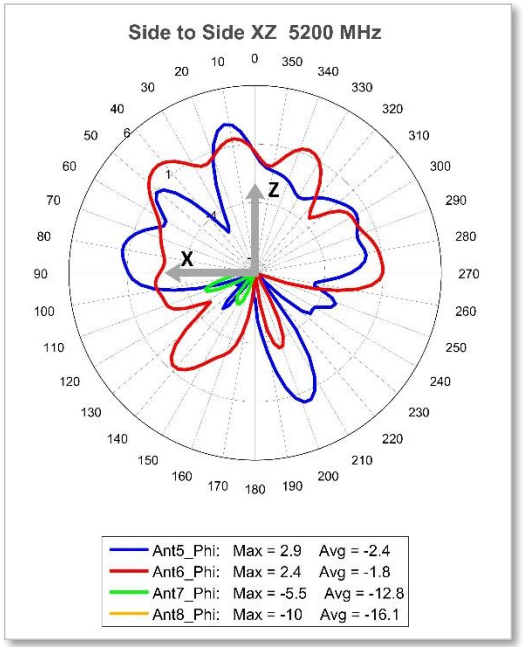


Front to Back (YZ)

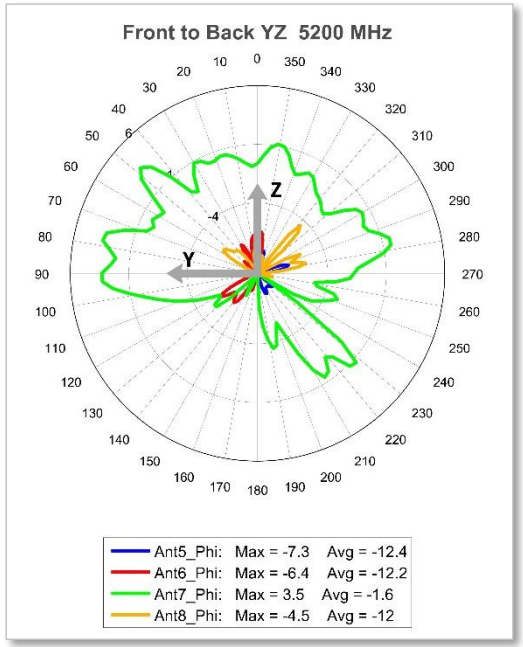
Wi-Fi Ant5-Ant8 2D Cut at 5.2GHz -Phi



Azimuth (XY)

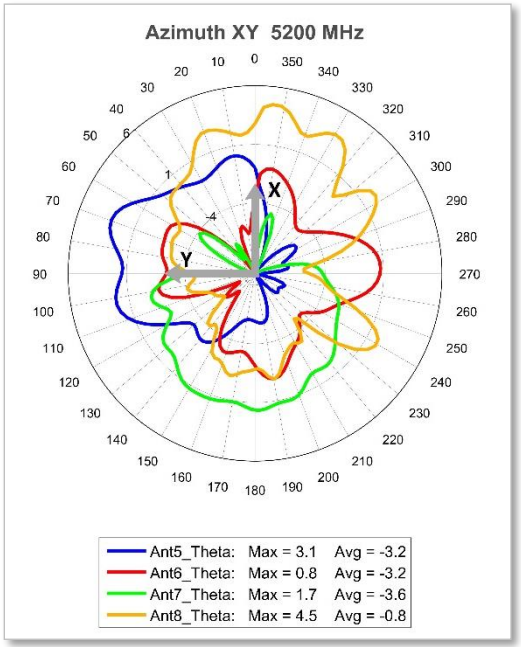


Side to Side (XZ)

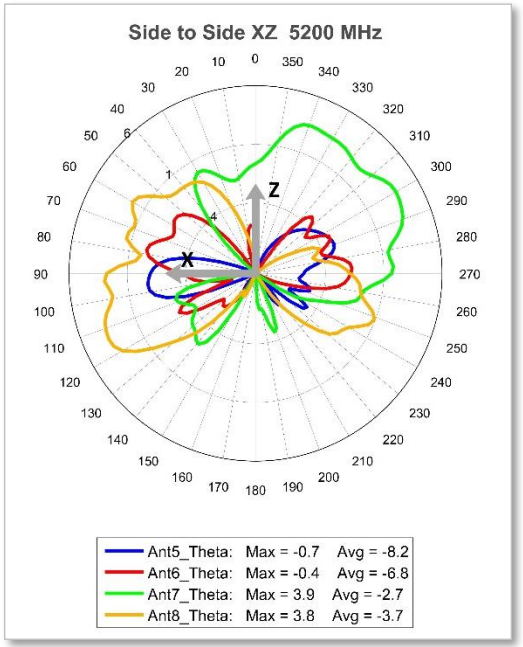


Front to Back (YZ)

Wi-Fi Ant5-Ant8 2D Cut at 5.2GHz -Theta



Azimuth (XY)



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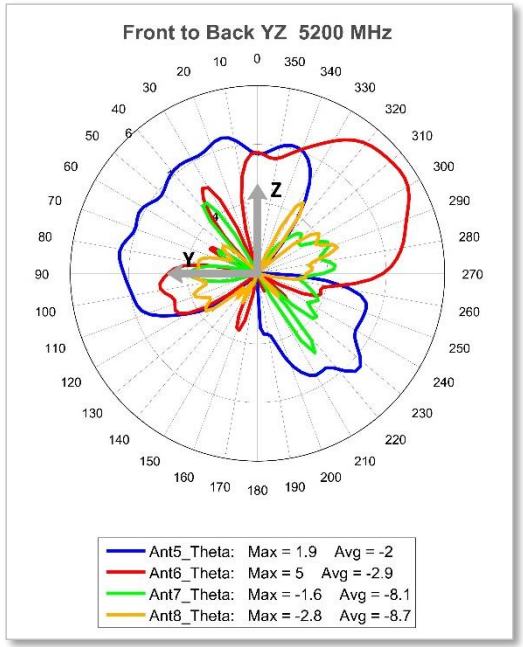
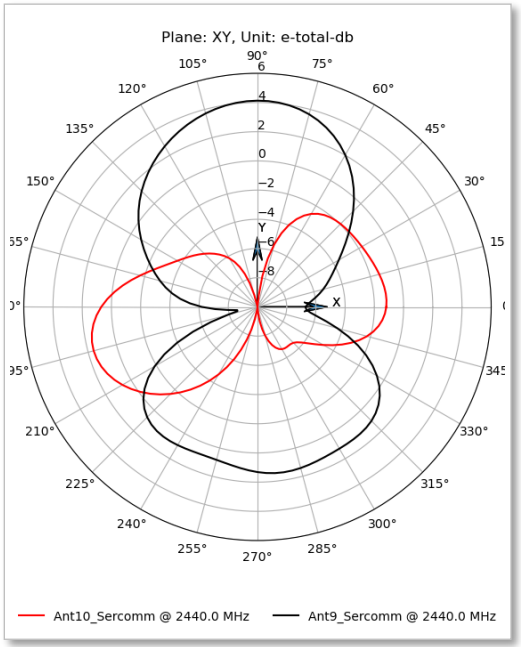
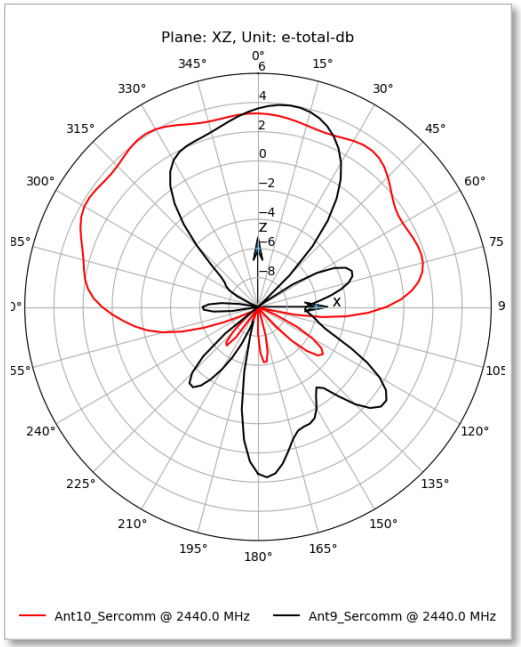


Front to Back (YZ)

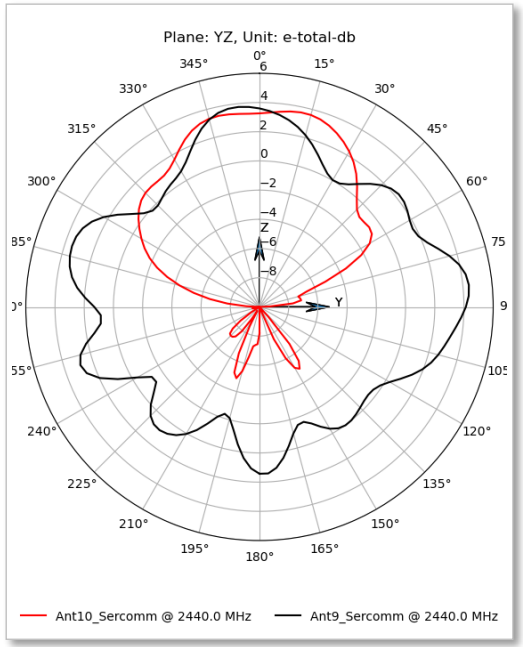
Zigbee Ant9-Ant10 2D Cut at 2.44GHz



Azimuth (XY)



Side to Side (XZ)



Front to Back (YZ)

Antenna System Composite Gain

Composite Gain Calculation

- The composite gain is based on FCC document 662911. Part d (ii)

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

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

Directional gain = $10 \log[(10^{G1/20} + 10^{G2/20} + \ldots + 10^{GN/20})^2 / N_{ANT}]$ 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.]

(ii) If all transmit signals are *completely uncorrelated*, then

Directional gain = $10 \log[(10^{G1/10} + 10^{G2/10} + \ldots + 10^{GN/10})/N_{ANT}]$ dBi

Reference: FCC document, "Emissions Testing of Transmitters with Multiple Outputs in the Same Band", 662911 D01 Multiple Transmitter Output v02r01

Composite Gain Calculation

Band	Phiº	Thetaº	Ant5	Ant6	Ant7	Ant8	Calculated Correlated Directional Gain
2.4G	33	90	-1.5052	-2.4998	2.2611	2.3181	6.43
NII-1	168	-87	-4.672	-1.0374	-6.3156	4.911	5.38
NII-2A	171	-90	-2.8772	-2.2058	-7.0598	4.5065	5.15
NII-2C	96	87	2.8927	-2.1484	-2.0439	-3.2659	5.23
NII-3	69	-63	-4.5343	4.1123	-2.3436	-2.2118	5.43

Step 1) For each antenna, measure the Theta / Phi radiation pattern.
Step 2) At each Theta / Phi coordinate, calculate the sum of all the antenna gains for Ant5+6+7+8 using the appropriate correlated formula for directional gain from KDB 662911 D01.
Step 3) The worst-case directional gains calculated from all measured coordinates is shown above.

Composite Gain Heatmaps AG 7A

AG 7A DVT 2 Unit

Composite Gain (dBi)

Ant5+Ant6+Ant7+Ant8

Freq (MHz)	Correlated Composite Gain	
	Phi (dBi)	Theta (dBi)
2400	5.66	5.94
2410	5.41	5.97
2420	5.41	5.94
2430	5.55	6.11
2440	5.68	6.32
2450	5.22	6.43
2460	4.58	6.40
2470	4.06	5.98
2480	4.28	5.87
2490	4.82	5.77

Maximum directional gain frequency at 2450MHz

$$\text{Directional gain} = 10\log\left(\frac{(10^{-1.5052/20}+10^{-2.4998/20}+10^{2.2611/20}+10^{2.3181/20})^2}{4}\right)$$

Gain	Phi°	Theta°
6.43	33	90

Composite Gain (dBi)

Ant5+Ant6+Ant7+Ant8

Freq (MHz)	Correlated Composite Gain	
	Phi (dBi)	Theta (dBi)
5150	4.12	5.38
5200	4.24	5.31
5300	3.90	5.15
5400	4.14	5.10
5500	4.14	5.23
5600	4.41	5.07
5700	4.42	5.09
5850	3.93	5.43

Maximum directional gain frequency at 5850MHz

$$\text{Directional gain} = 10\log\left(\frac{(10^{-4.5343/20} + 10^{4.1123/20} + 10^{-2.3436/20} + 10^{-2.2118/20})^2}{4}\right)$$

Gain	Phi°	Theta°
5.43	69	-63

Composite Gain (dBi)

Ant1+Ant2+Ant3+Ant4

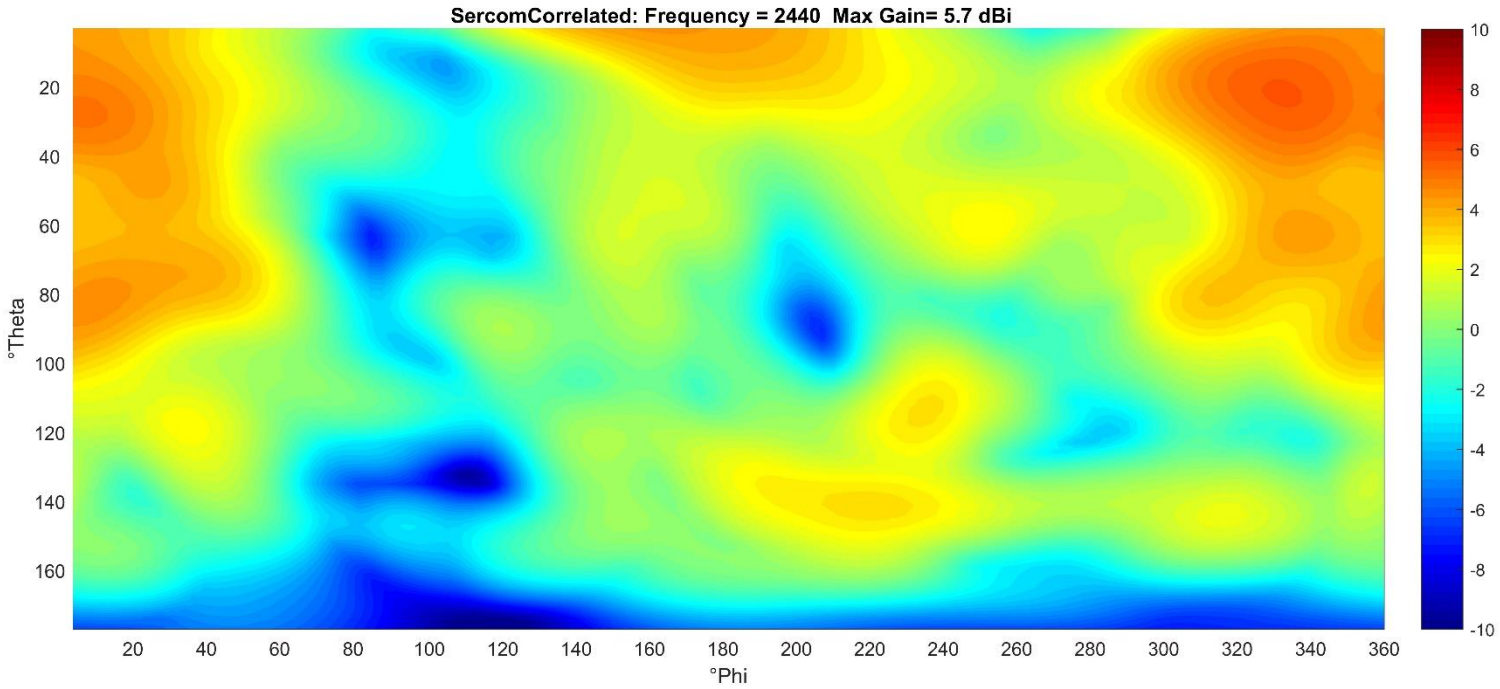
Freq (MHz)	Correlated Composite Gain	
	Phi (dBi)	Theta (dBi)
5925	7.65	6.02
6000	7.25	5.83
6100	7.50	6.23
6200	7.67	6.69
6300	7.93	7.26
6400	7.59	6.96
6500	7.35	7.30
6600	7.18	7.41
6700	7.07	7.41
6800	6.69	7.28
6900	6.77	6.80
7000	6.81	6.93
7100	6.42	6.35
7125	6.48	6.14

Maximum directional gain frequency at 6300MHz

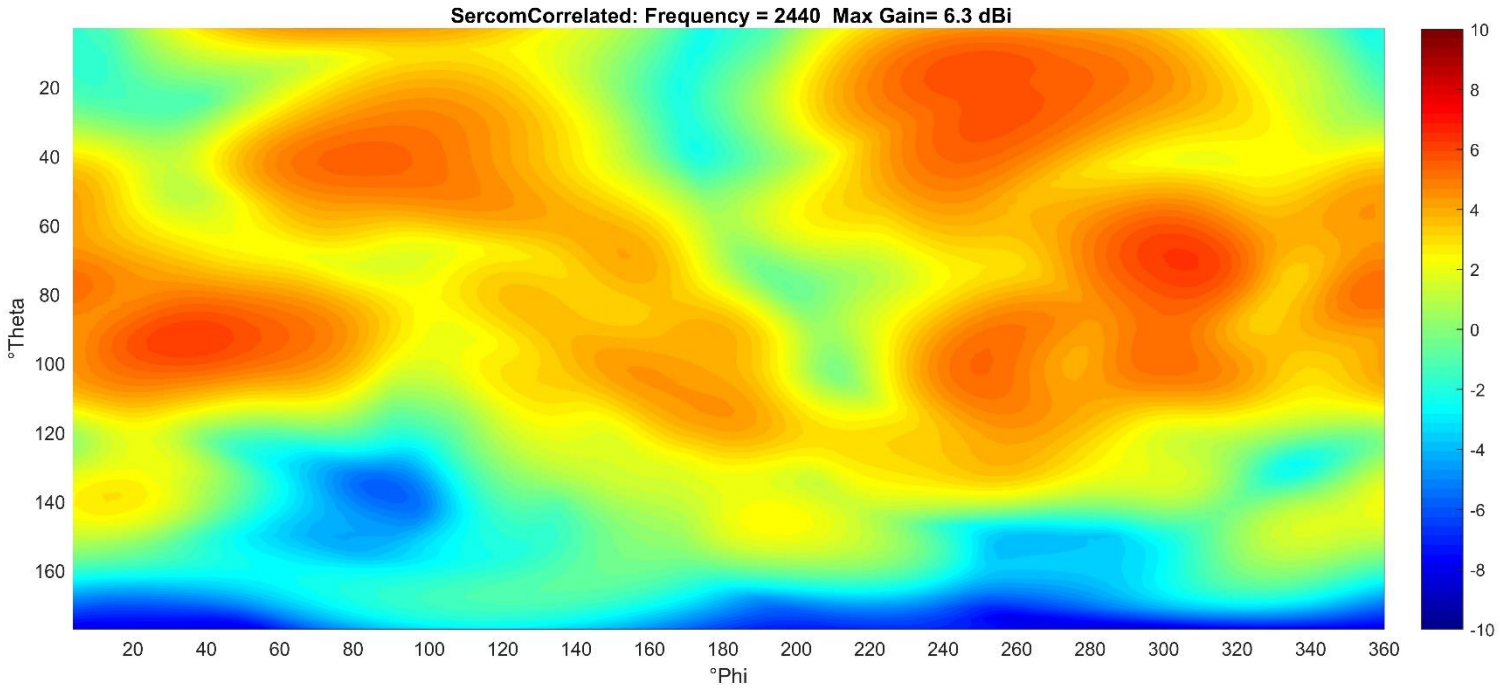
$$\text{Directional gain} = 10\log\left(\frac{(10^{0.38137/20} + 10^{-0.52582/20} + 10^{4.3145/20} + 10^{2.6357/20})^2}{4}\right)$$

Gain	Phi°	Theta°
7.93	3	51

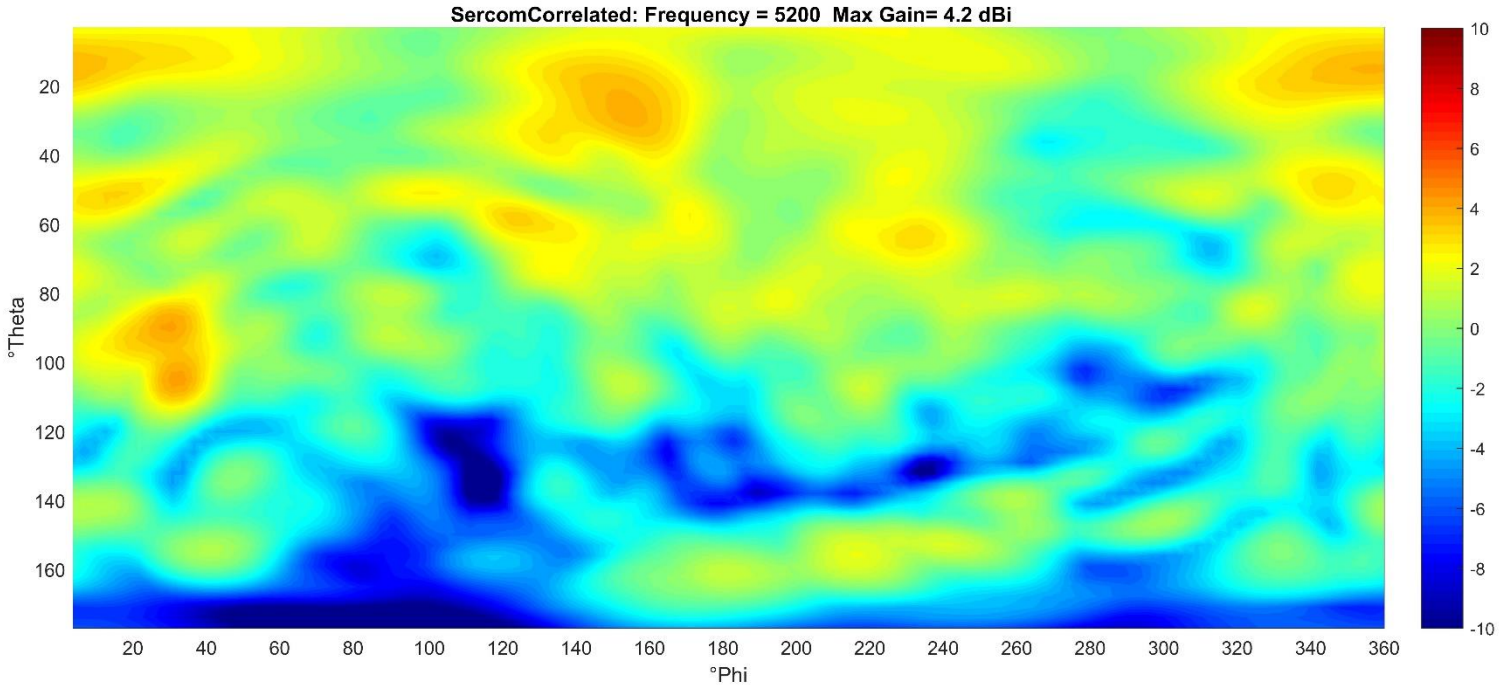
Correlated Composite Gain for Ant5, Ant6, Ant7 and Ant8 at 2.44 GHz Band of Operation Phi Gain



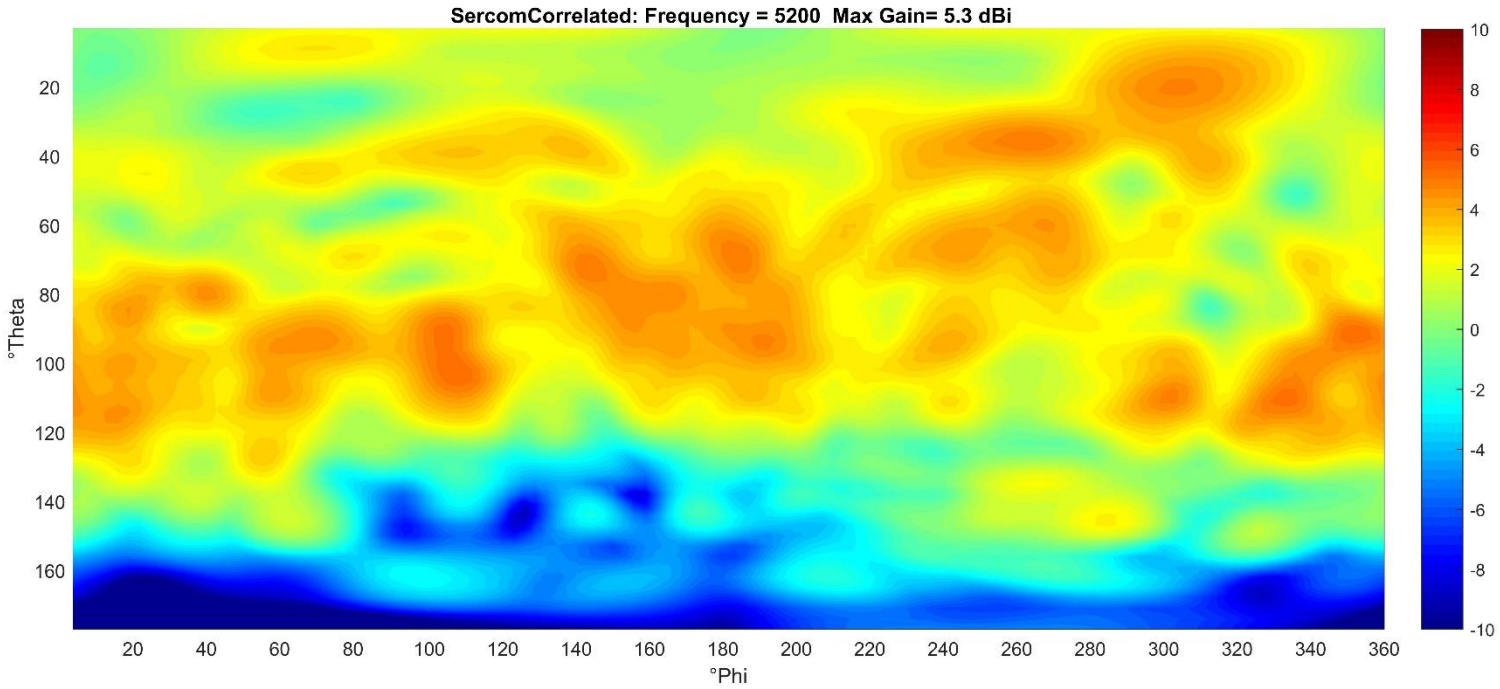
Correlated Composite Gain for Ant5, Ant6, Ant7 and Ant8 at 2.44 GHz Band of Operation Theta Gain



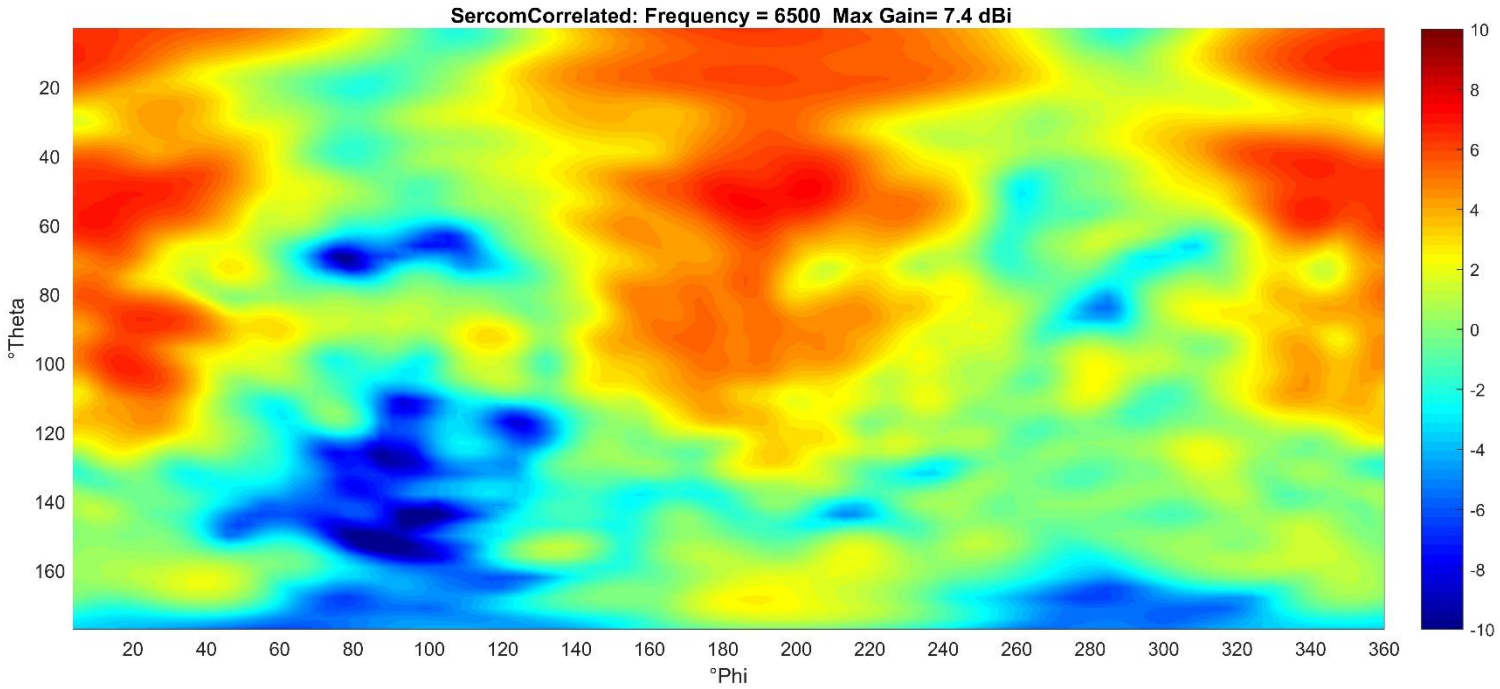
Correlated Composite Gain for Ant5, Ant6, Ant7 and Ant8 at 5.2 GHz Band of Operation Phil Gain



Correlated Composite Gain for Ant5, Ant6, Ant7 and Ant8 at 5.2 GHz Band of Operation Theta Gain



Correlated Composite Gain for Ant1, Ant2, Ant3 and Ant4 at 6.5GHz Band of Operation Phi Gain



Correlated Composite Gain for Ant1, Ant2, Ant3 and Ant4 at 6.5GHz Band of Operation Theta Gain