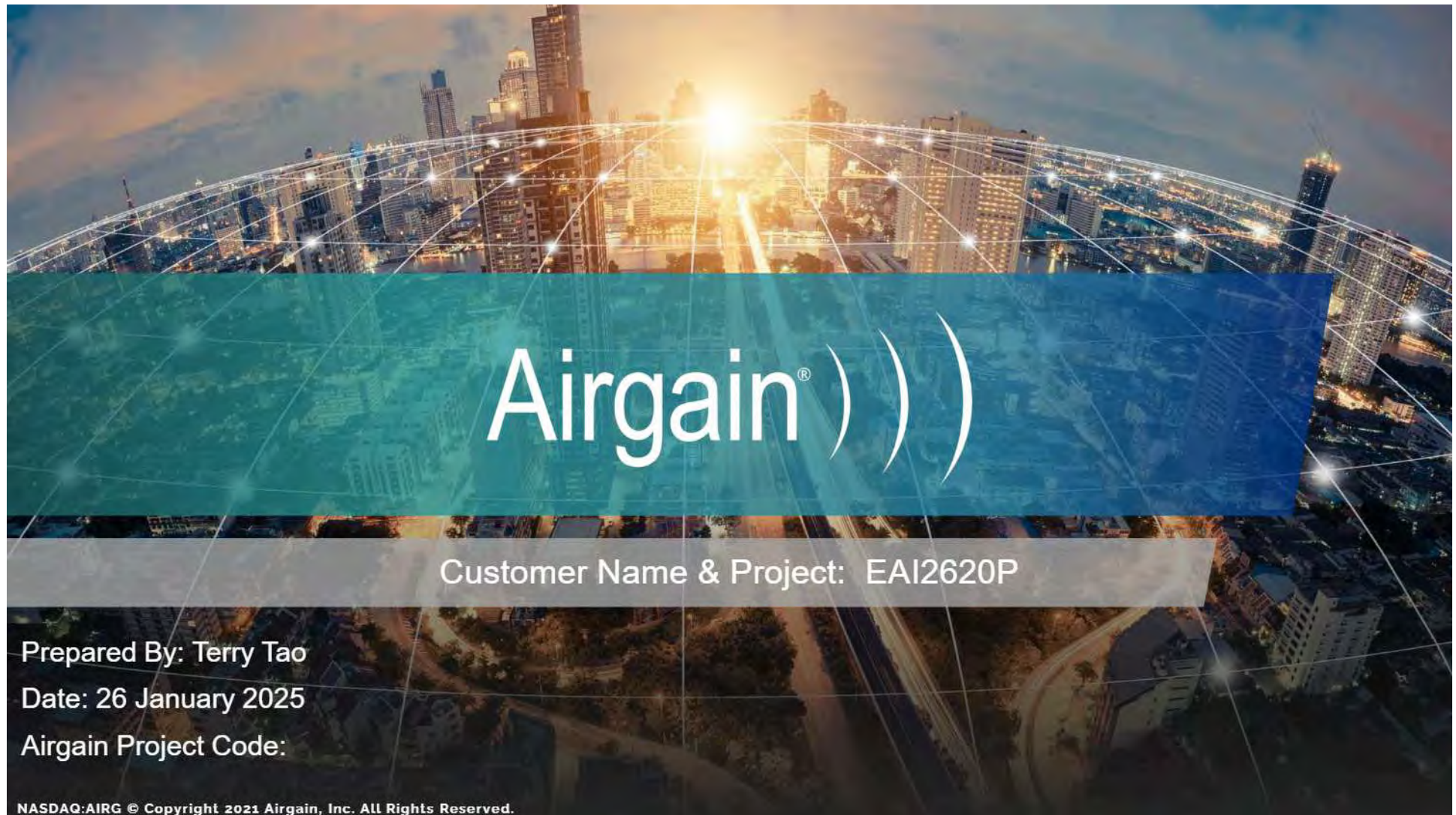




Introduction



- Airgain proposes an embedded antenna solution for EAI2620P
 - **The antenna solution is updated based upon the latest 3D provided customer**

DUT Description



- The solution for this device is as follows:
 - **Cable-fed Antennas:**
 - 4 pcs 2G Antennas(2.4GHz-2.49GHz)
 - 4 pcs 6G Antennas(5.925GHz-7.125GHz)
 - 4 pcs 5G Antennas(5.15GHz-5.85GHz)
- The antenna is mounted on the metal plate and connect to the radio through coaxial cable and U.FL. Connector
- Passive measurement results are presented

Summary of Requirements



- Return Loss :
All band $< -10\text{dB}$
- Isolation:
Isolation between antennas $< -20\text{dB}$
- Efficiency:
● More than 50% for all antenna



Airgain Antenna System Proposal

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S-Parameters

Actual Equipment List and Calibration Information

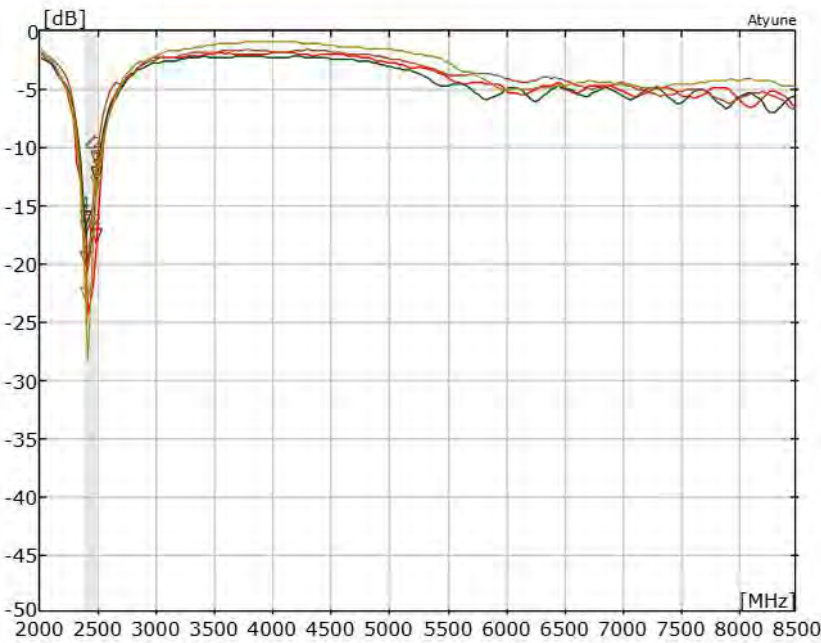


Vendor	Model	Calibrated Date	Calibrated Until
Agilent Technologies	E5071B	2024/12/11	2025/12/11



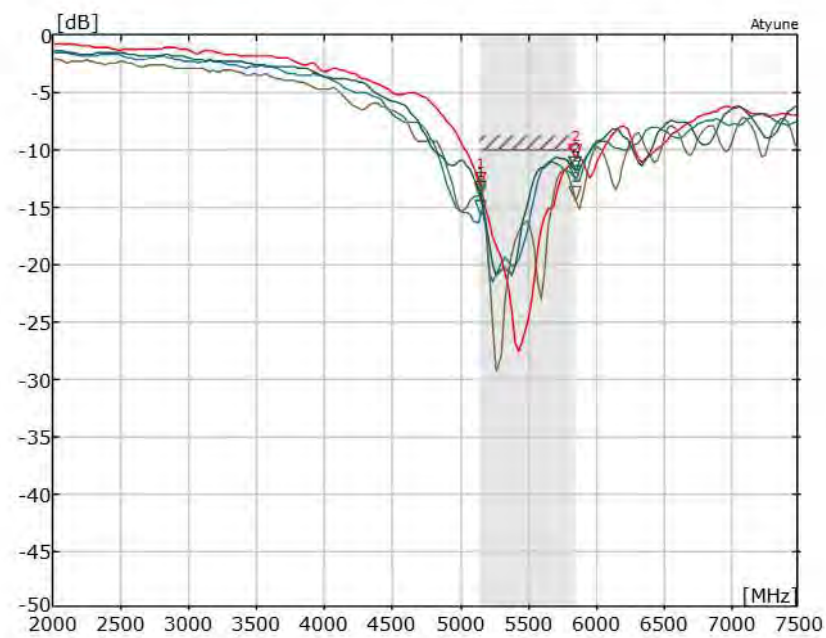
- Test personnel : Terry Tao
- Test date : 26st January 2025

S-Parameter – Return Loss for 2G band Antennas



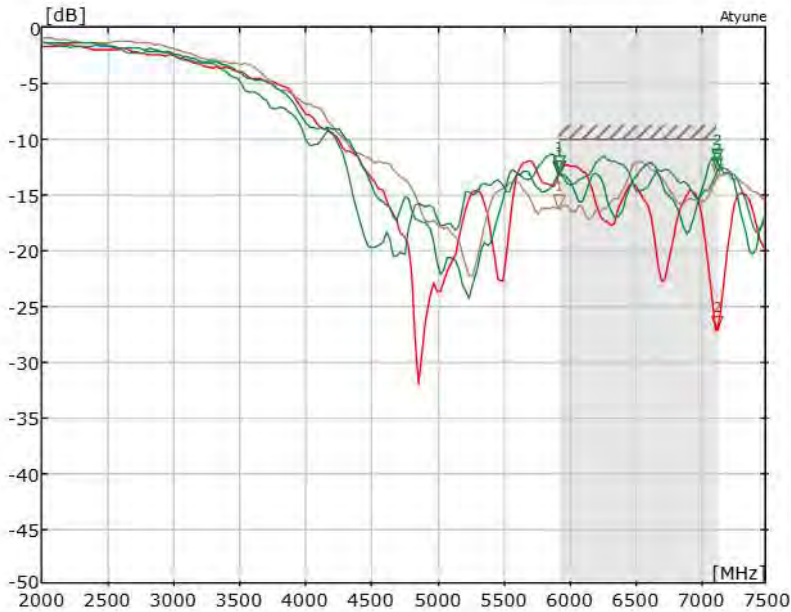
MARKERS:	MHz	dB
Ant2		
1:	2400	-17.40
2:	2490	-18.11
Ant3		
1:	2400	-16.60
2:	2490	-12.77
Ant4		
1:	2400	-20.10
2:	2490	-11.47
Ant5		
1:	2400	-23.06
2:	2490	-13.63

S-Parameter – Return Loss for 5G Antennas



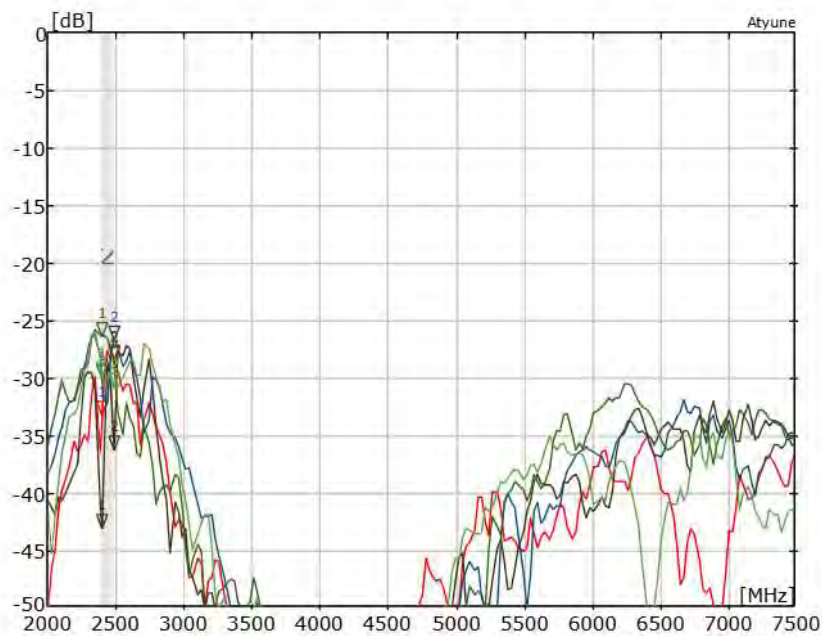
MARKERS:	MHz	dB
Ant10		
1:	5150	-13.07
2:	5850	-10.74
Ant7		
1:	5150	-15.55
2:	5850	-12.49
Ant8		
1:	5150	-14.18
2:	5850	-14.32
Ant9		
1:	5150	-13.86
2:	5850	-11.70

S-Parameter – Return Loss for 6G Antennas



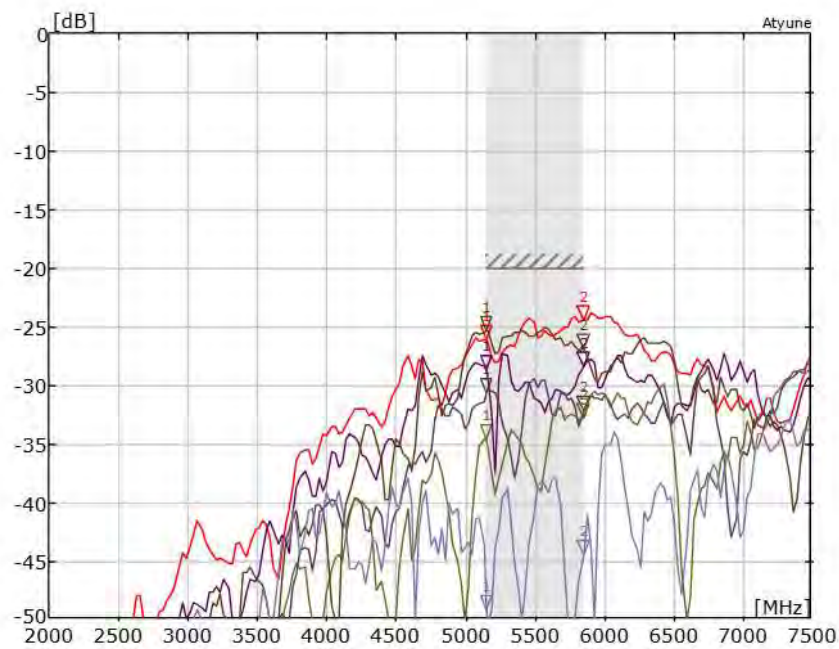
MARKERS:	MHz	dB
Ant11		
1:	5925	-13.12
2:	7125	-27.07
Ant12		
1:	5925	-16.12
2:	7125	-13.35
Ant13		
1:	5925	-13.14
2:	7125	-11.98
Ant14		
1:	5925	-12.67
2:	7125	-12.81

S-Parameter – Isolation between all 2G Antennas



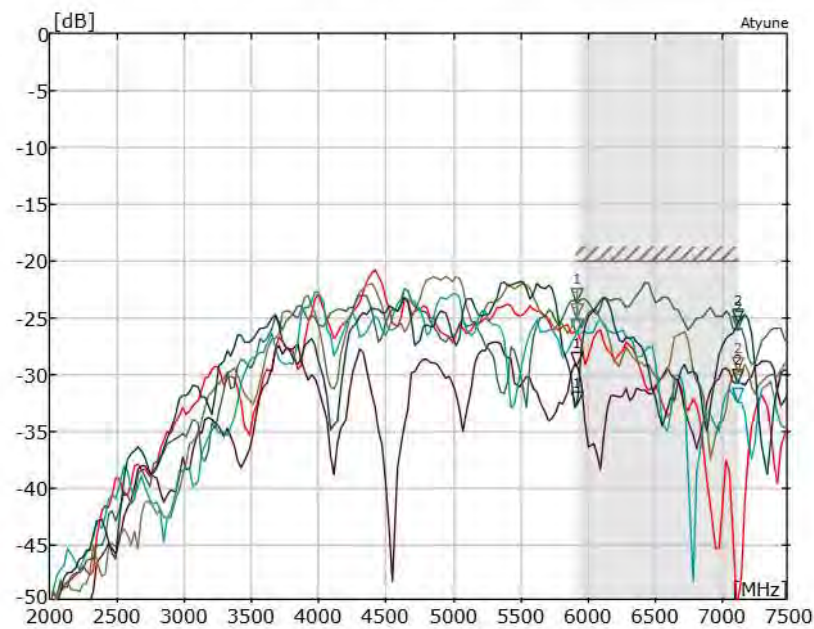
MARKERS:	MHz	dB
A2-A3.S2P - S12		
1:	2400	-33.12
2:	2490	-28.40
A2-A4.S2P - S12		
1:	2400	-42.96
2:	2490	-36.15
A3-A4.S2P - S12		
1:	2400	-29.90
2:	2490	-26.53
A3-A5.S2P - S12		
1:	2400	-26.34
2:	2490	-28.32
A4-A5.S2P - S12		
1:	2400	-29.77
2:	2490	-30.74

S-Parameter – Isolation between all 5G Antennas



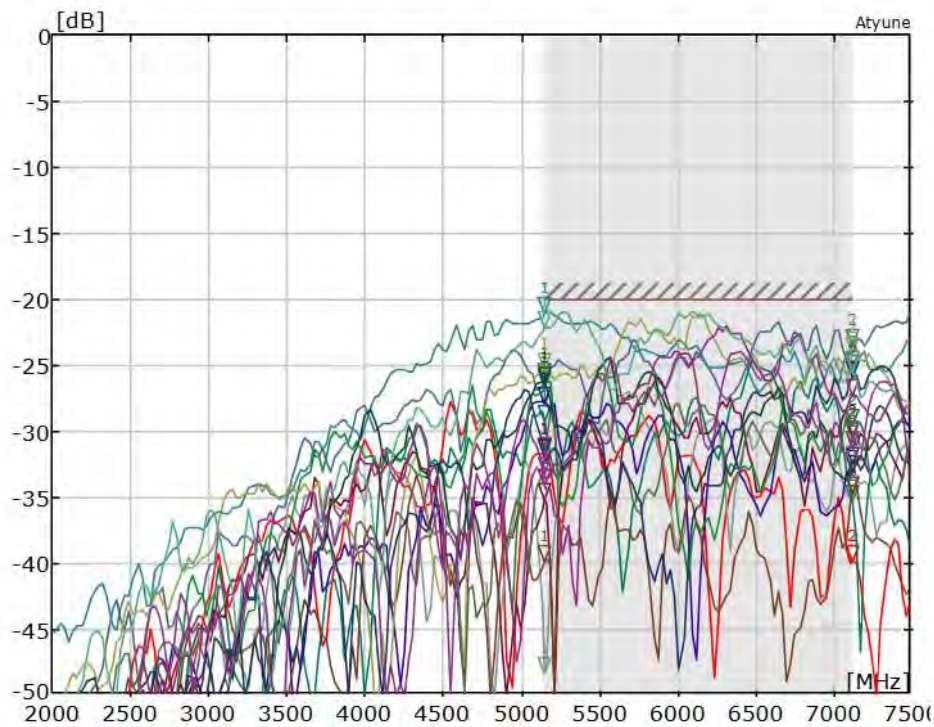
MARKERS:	MHz	dB
A7-A10.S2P - S12		
1:	5150	-26.00
2:	5850	-24.37
A7-A8.S2P - S12		
1:	5150	-28.62
2:	5850	-28.28
A7-A9.S2P - S12		
1:	5150	-30.58
2:	5850	-32.05
A8-A10.S2P - S12		
1:	5150	-34.50
2:	5850	-32.62
A8-A9.S2P - S12		
1:	5150	-25.29
2:	5850	-26.70
A9-A10.S2P - S12		
1:	5150	-48.96
2:	5850	-44.26

S-Parameter – Isolation between 6G Antennas



MARKERS:	MHz	dB
A11-A12.S2P - S12		
1:	5925	-26.27
2:	7125	-50.30
A11-A13.S2P - S12		
1:	5925	-29.18
2:	7125	-30.73
A11-A14.S2P - S12		
1:	5925	-24.89
2:	7125	-29.70
A12-A13.S2P - S12		
1:	5925	-23.56
2:	7125	-25.91
A12-A14.S2P - S12		
1:	5925	-26.28
2:	7125	-32.28
A13-A14.S2P - S12		
1:	5925	-32.72
2:	7125	-25.38

S-Parameter – Isolation between 5G&6G Antennas



MARKERS:	MHz	dB
A10-A11.S2P - S12		
1:	5150	-31.52
2:	7125	-39.78
A10-A12.S2P - S12		
1:	5150	-48.29
2:	7125	-34.40
A10-A13.S2P - S12		
1:	5150	-29.09
2:	7125	-35.16
A10-A14.S2P - S12		
1:	5150	-26.03
2:	7125	-23.34
A7-A11.S2P - S12		
1:	5150	-21.04
2:	7125	-25.09
A7-A12.S2P - S12		
1:	5150	-35.12
2:	7125	-30.41
A7-A13.S2P - S12		
1:	5150	-27.74
2:	7125	-32.90
A7-A14.S2P - S12		
1:	5150	-26.53
2:	7125	-29.41

A8-A11.S2P - S12		
1:	5150	-39.71
2:	7125	-34.57
A8-A12.S2P - S12		
1:	5150	-25.19
2:	7125	-24.07
A8-A13.S2P - S12		
1:	5150	-26.31
2:	7125	-32.30
A8-A14.S2P - S12		
1:	5150	-31.67
2:	7125	-30.52
A9-A11.S2P - S12		
1:	5150	-31.73
2:	7125	-25.81
A9-A12.S2P - S12		
1:	5150	-34.05
2:	7125	-27.25
A9-A13.S2P - S12		
1:	5150	-22.12
2:	7125	-25.44
A9-A14.S2P - S12		
1:	5150	-33.18
2:	7125	-31.13



Radiated Measurements

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The collage consists of four screenshots:

- Top-left:** A license agreement window for "Salimo Passive Measurement 1.8.0". It contains the SATIMO logo and text regarding the software's use, redistribution, and source code availability. It includes an "OK" button at the bottom right.
- Top-right:** A version information window for "salenv.exe 3.0.3.0 build 23". It provides the URL "http://www.salimo.fr" and "http://www.metraware.com", the company name "S atsim", and a security ID. It also displays a security code and a limit date of use: "Friday, December 31, 2049". An "OK" button is at the bottom right.
- Bottom-left:** The main interface of the "MV Sphere" software. It shows a 3D model of an antenna array. A red message box in the center states "Update required...". The interface includes a menu bar and a toolbar.
- Bottom-right:** The "Settings" window of the "MV Sphere" software. It contains various configuration options organized into sections: "Power Warning", "Antenna", "Measurement", "General", and "Advanced". Each section has a "Reset" button. The "General" section includes fields for "Unit type", "Frequency", "Power", "Status", and "Display".

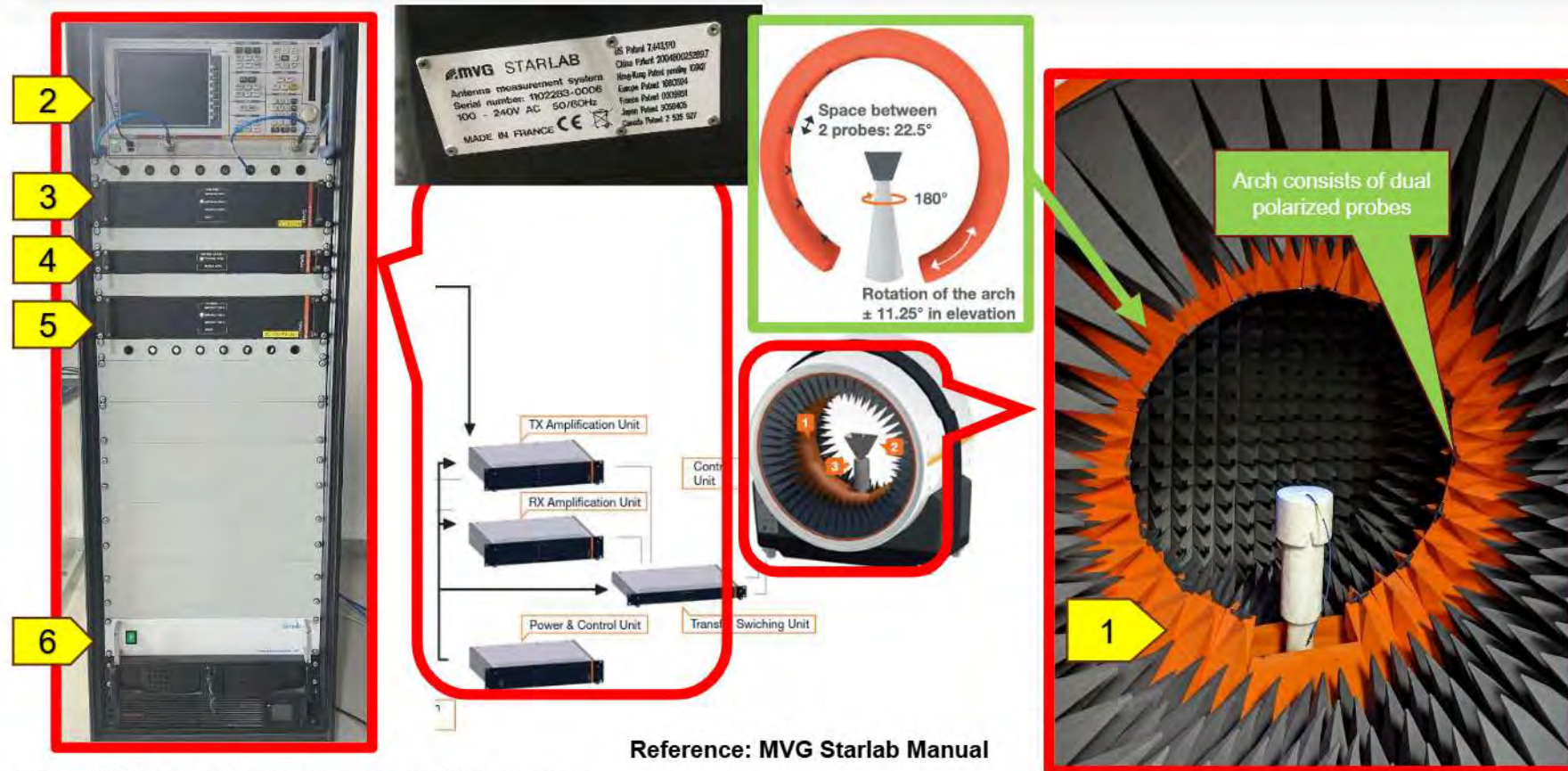
Test Equipment and Calibration



No	Instrument	Brand	Characteristics	Model No	Serial No	Calibration Due
1	Anechoic Chamber	MVG	600MHz-10GHz	Star Lab	1102283-0006	December 2024
2	VNA	ROHDE&SCHWARZ	300kHz-8GHz	ZVB.8	100225	August 2024
3	Tx Amplifier	MVG	NA	TxAU	1102527-4551	December 2024
4	Transfer Switching Unit	MVG	NA	TSU	1102183-26343	December 2024
5	Rx Amplifier	MVG	NA	RxAU	1102564-3748	December 2024
6	Power and Control Unit	MVG	NA	PACU	1101225-2238	December 2024

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Measurement setup Architecture



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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 $\pm 11.25^\circ$ 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

Measurement Procedure



➤ DUT Setup

- Mount the DUT securely on the Starlab's positioning system.
- Ensure the antenna's phase center aligns with the system's rotation center.
- Connect the RF feed to the AUT using a phase-stable cable in the chamber.

➤ Measurement Setup

- Open SPM and Satenv
- Configure the settings of frequency, Oversampling.

➤ Data Acquisition

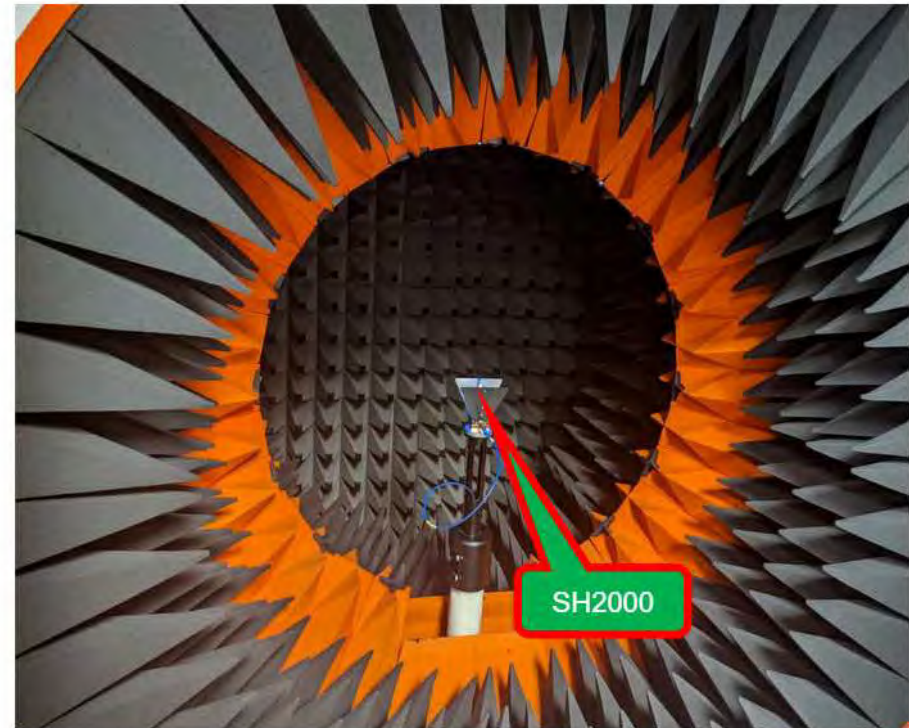
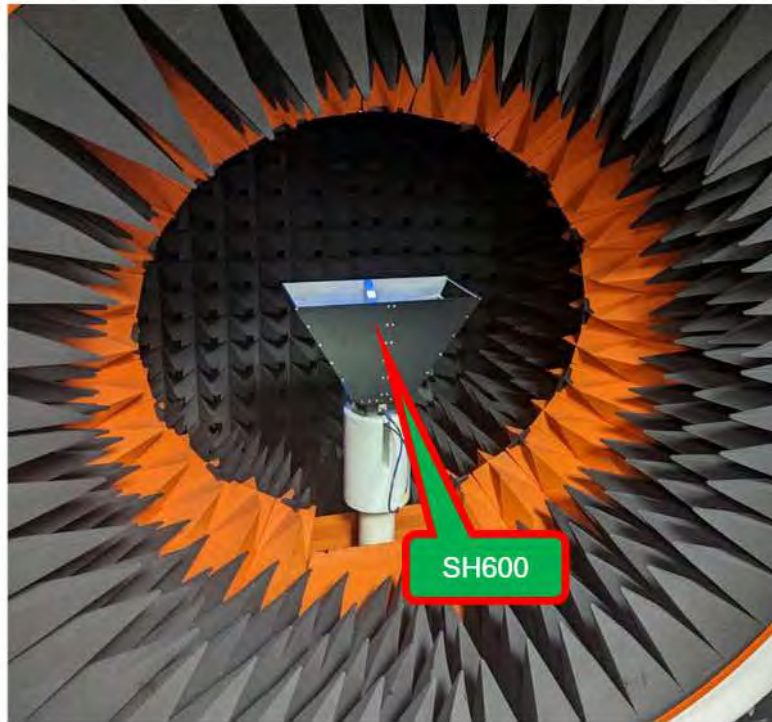
- Start the scan. VNA No2 as the equipment used for testing.
- The RF power is transmitted out of the antenna under test. This RF power is fed through VNA No2 to TxAU No3 through the TSU No4.
- The Near field energy out of the Antenna is captured by the Vertical and Horizontal polarized probes on the ring.
- The captured power passes through TSU No4 to RxAU No5 and finally to VNA No2.
- The Phi angle on of the turn table rotates from 0-177 degrees and the ring captures the signal and writes in the data matrix for each frequency.
- The offsets to +-11.25 degrees to capture the near field in the angles in between the probes.
- Nearfield data is stored.

➤ Post Processing and Results

- Upon completion of measurements the postprocessing is done with Satenv.
- The measured data is computed against calibrated file (*Please check Calibration Process on Slide 7*) for reconstruction and transition of the far field data at each measurement frequency.
- The data is loaded into SatEnv to plot the measurement parameters and the plots

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Passive Antenna Calibration Setup



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Passive Antenna Calibration (Gain Substitution Method)



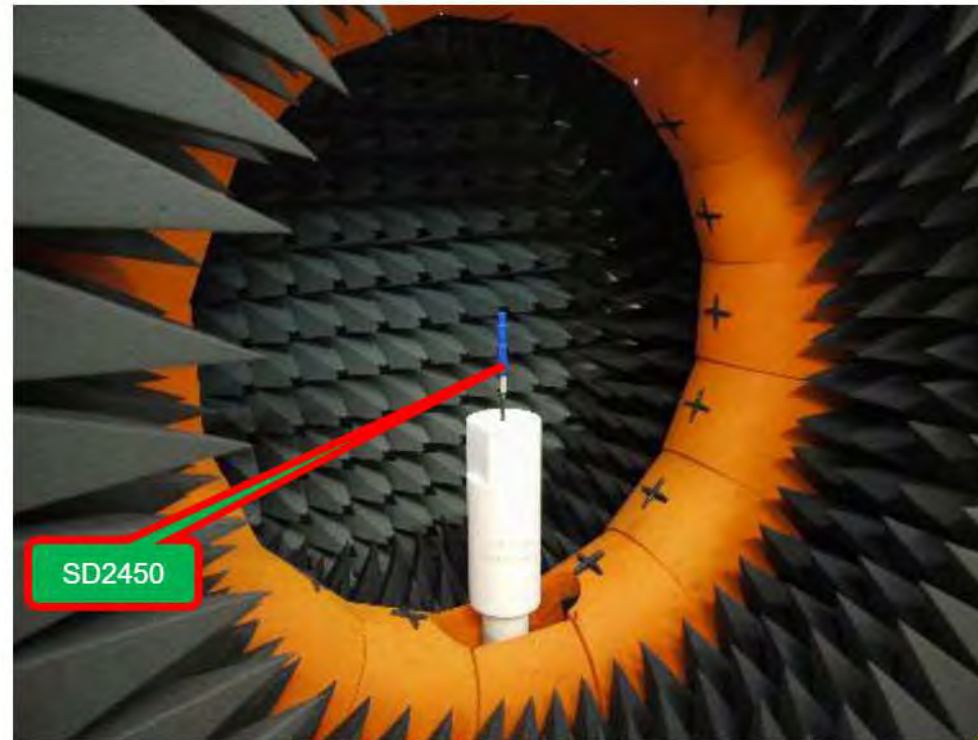
- Starlab is calibrated on a week basis by using MVG calibration method
- A standard Satimo horn antenna SH600 and SH2000 are used for calibrating the changer in low and high frequency bands of operation
- The horn antennas are measured in the chamber and the calibration is performed in post processing 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



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Passive Antenna Validation Setup



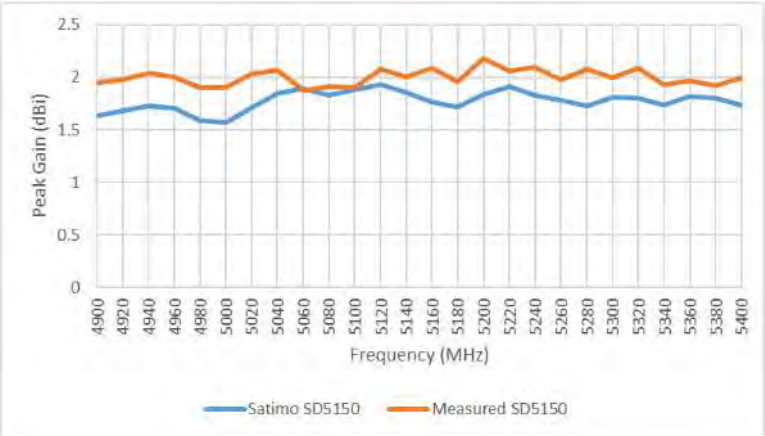
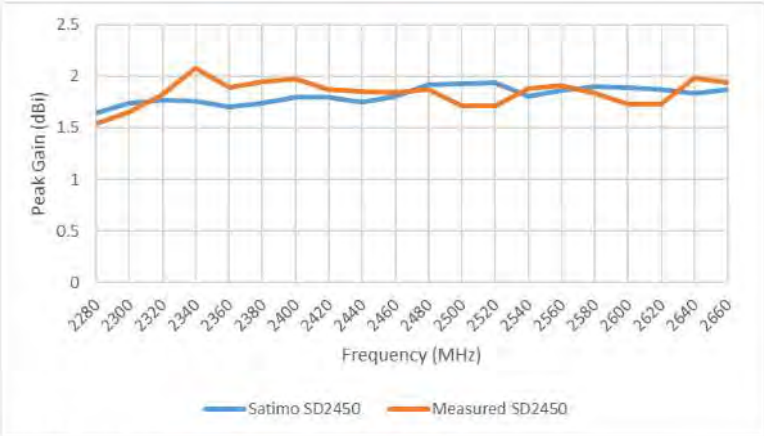
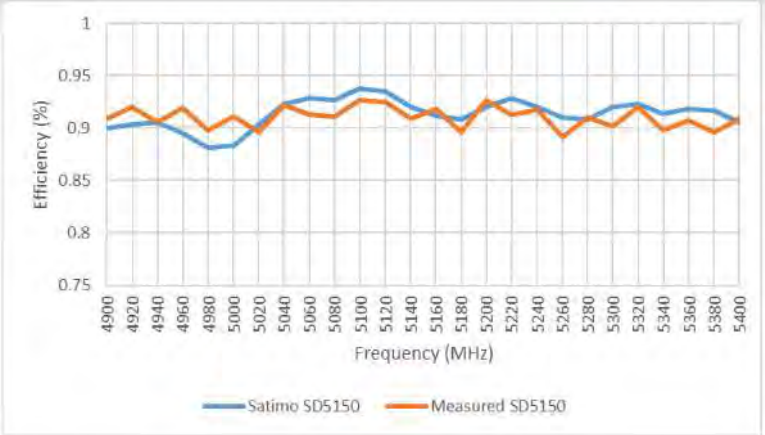
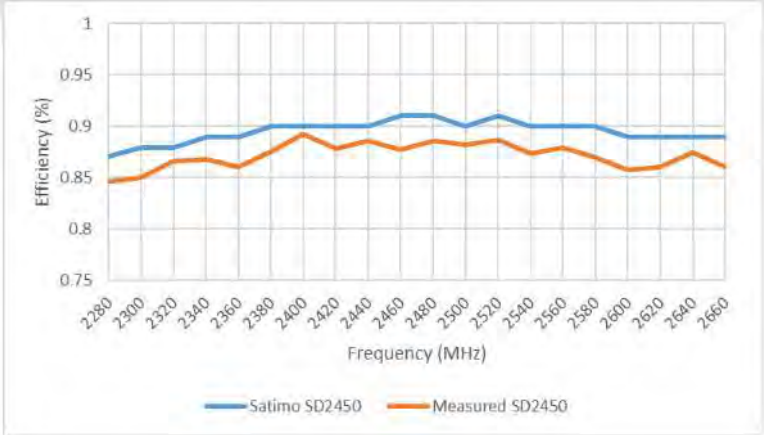
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Passive Antenna Validation



- 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 SD2450, 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

Passive Antenna Validation Results



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- Technical Document - MATR.346.1.24.HKG.A

- MA.1.4.D Orthomodal Calibration Procedure.pdf

	Name	Function	Date	Signature
Prepared by	Rex XUE	Aftersales Engineer	11-Dec-2024	
Checked by	FredERIC CABARET	Aftersales Manager	11-Dec-2024	

chrome-extension://oemmndcbldboiebfnladdacbfmdadm/https://api2-c-de.ilovepdf.com/v1/download/q94zXfp5wbxtnpfn17gtwmpAwtdm6kmfb3rbpAxx8203d6vr4kx7xmcw1dz0r27vyg86dAbz4zptlrm1tkyz17bvk9... 28/68

MVG Chamber Validations/ Calibrations Data

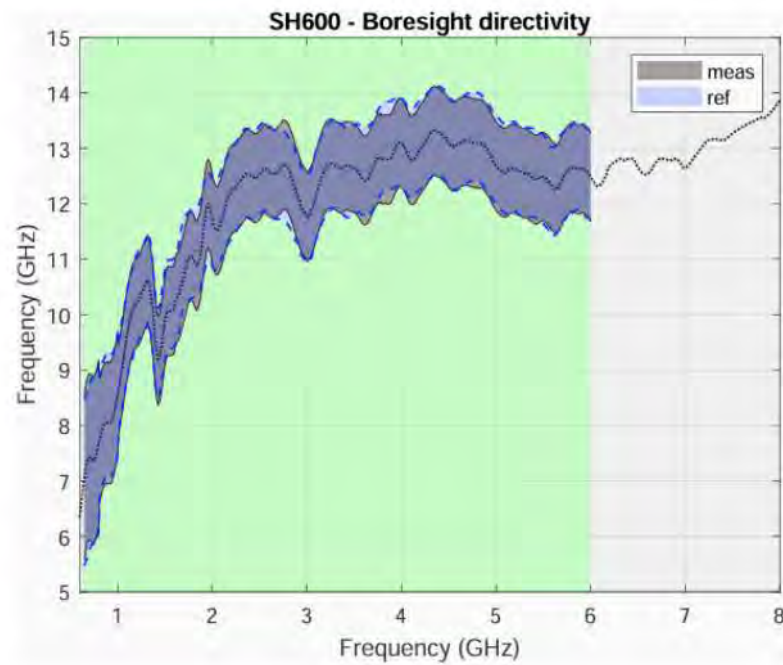


Figure 5.1: Boresight directivity

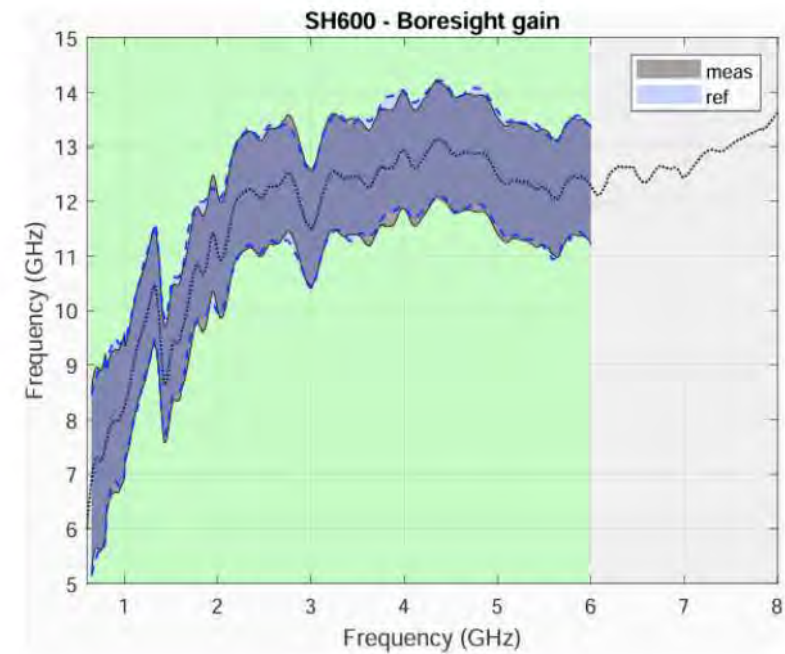


Figure 5.2: Boresight gain

MVG Chamber Validations/ Calibrations Data

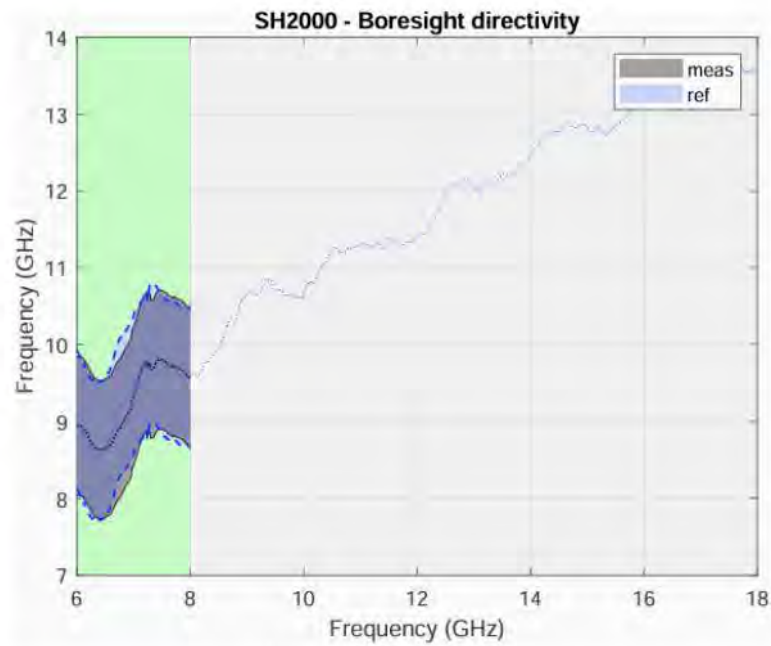


Figure 5.68: Boresight directivity

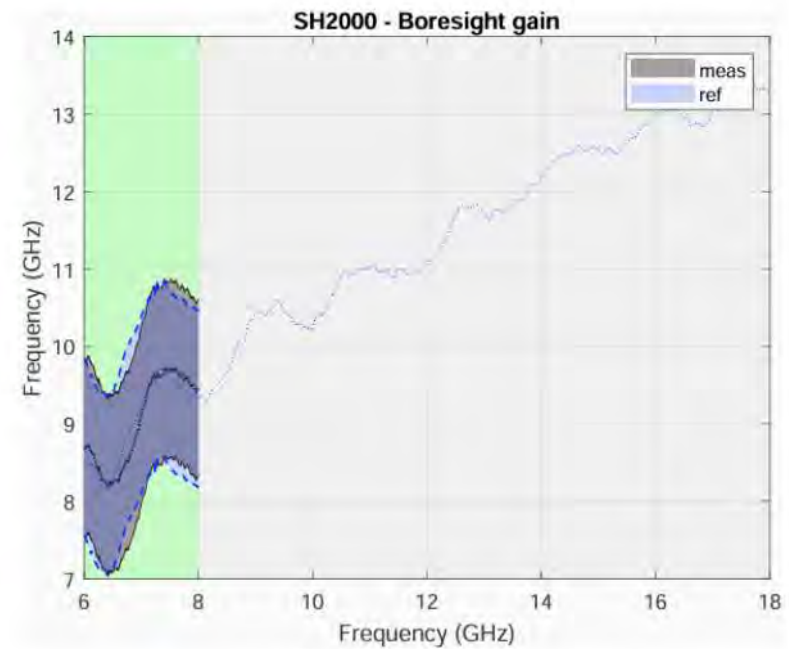


Figure 5.69: Boresight gain

MVG Chamber Validations/ Calibrations Data

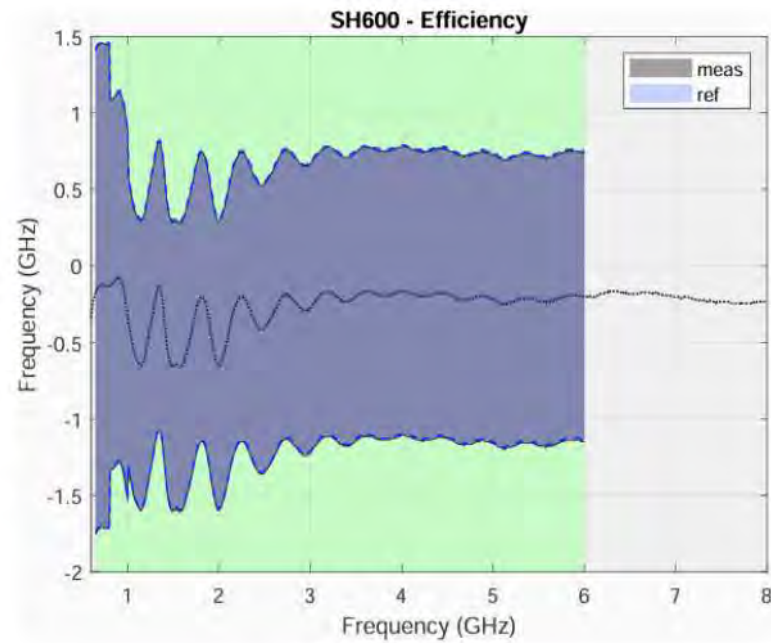


Figure 5.3: Efficiency

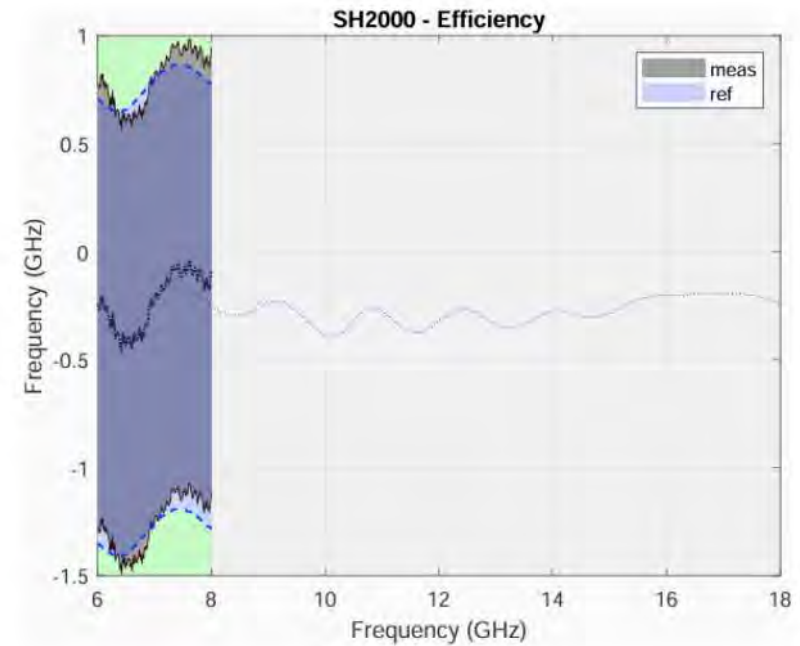


Figure 5.70: Efficiency

Conclusions



- Return Loss:
Below -10dB for all antennas
- Isolation:
Below -20dB between all antennas
- Efficiency :
2G > 50%, 5G >50%
6G > 60%



Radiation Patterns

Antenna Realized Efficiency (%) – 2.4 GHz Wi-Fi Antennas



Frequency (MHz)	Ant2_2G4 (%)	Ant3_2G4 (%)	Ant4_2G4 (%)	Ant5_2G4 (%)
2400	55.0	67.7	68.0	76.7
2410	56.5	68.5	67.3	76.6
2420	56.4	66.9	65.5	75.8
2430	56.6	67.3	65.4	75.9
2440	56.8	68.1	66.0	76.6
2450	55.7	68.1	66.2	76.4
2460	54.0	68.0	66.4	76.5
2470	51.6	66.6	65.8	76.2
2480	50.9	65.7	65.3	76.2
2490	52.1	64.7	64.9	76.7
Average	54.6	67.2	66.1	76.4

Antenna Realized Efficiency (%) – 5 GHz Wi-Fi Antennas



Frequency (MHz)	Ant7_5G (%)	Ant8_5G (%)	Ant9_5G (%)	Ant10_5G (%)
5150	68.2	59.9	66.6	73.1
5200	68.2	59.6	67.8	74.5
5300	64.2	61.4	67.4	77.9
5400	65.3	58.8	66.7	76.8
5500	66.2	59.7	61.3	76.8
5600	61.0	57.7	57.2	72.0
5700	56.1	54.5	58.8	71.9
5800	55.4	53.6	57.9	62.5
5850	55.2	52.6	56.6	58.4
Average	62.2	57.5	62.2	71.6

Antenna Realized Efficiency (%) – 6 GHz Wi-Fi Antennas



Frequency (MHz)	Ant11_6G (%)	Ant12_6G (%)	Ant13_6G (%)	Ant14_6G (%)
5925	66.8	75.0	65.7	65.3
6000	63.6	76.1	69.3	67.4
6100	64.1	78.9	67.8	70.0
6200	65.8	79.3	67.2	67.6
6300	66.6	79.1	68.0	65.9
6400	66.4	75.7	67.5	63.8
6500	65.3	73.7	66.8	66.7
6600	65.3	70.9	65.1	67.7
6700	67.5	72.8	68.0	64.3
6800	67.4	75.5	69.5	65.5
6900	64.9	77.1	68.9	66.4
7125	65.6	73.3	64.5	62.4
Average	65.8	75.6	67.3	66.1

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Antenna Peak Realized Gain – 2.4 GHz Wi-Fi Antennas



Frequency (MHz)	Ant2_2G4 (dBi)	Ant3_2G4 (dBi)	Ant4_2G4 (dBi)	Ant5_2G4 (dBi)
2400	1.8	3.0	3.0	3.9
2410	1.8	3.1	3.0	4.0
2420	1.8	3.0	2.7	4.1
2430	1.9	3.3	2.6	4.2
2440	2.0	3.5	2.5	4.2
2450	2.0	3.7	2.5	4.2
2460	1.9	3.7	2.5	4.2
2470	1.9	3.6	2.5	4.2
2480	2.3	3.5	2.6	4.3
2490	2.5	3.3	2.7	4.3

Antenna Peak Realized Gain – 5 GHz Wi-Fi Antennas



Frequency (MHz)	Ant7_5G (dBi)	Ant8_5G (dBi)	Ant9_5G (dBi)	Ant10_5G (dBi)
5150	3.7	3.4	5.7	5.2
5200	4.4	4.3	5.6	4.6
5300	3.3	3.5	3.7	5.0
5400	4.0	4.1	5.5	5.4
5500	4.1	4.7	4.0	5.5
5600	3.2	4.0	4.5	5.2
5700	3.9	4.1	5.0	5.7
5800	4.7	4.3	4.2	6.3
5850	3.9	4.8	4.3	5.8

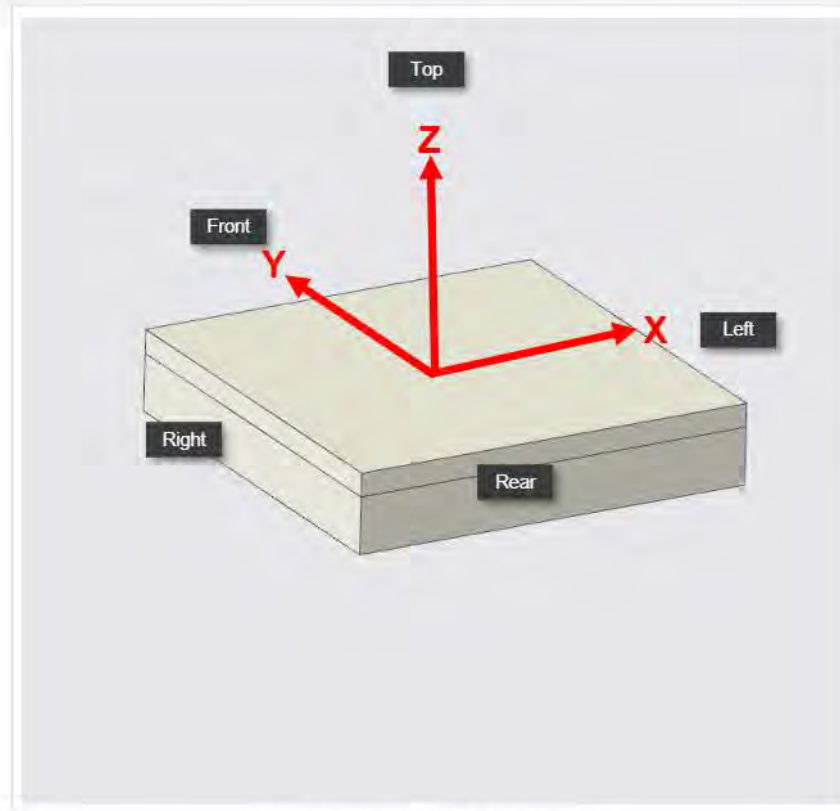
Antenna Peak Realized Gain – 6 GHz Wi-Fi Antennas



Frequency (MHz)	Ant11_6G (dBi)	Ant12_6G (dBi)	Ant13_6G (dBi)	Ant14_6G (dBi)
5925	5.5	5.9	5.7	5.9
6000	5.5	6.1	5.4	7.1
6100	4.9	6.4	5.4	6.2
6200	4.7	5.8	6.3	5.8
6300	5.4	5.5	6.3	5.9
6400	5.3	5.9	7.6	6.4
6500	5.3	6.2	7.4	6.7
6600	4.5	6.1	6.8	6.7
6700	5.0	6.2	6.6	6.2
6800	5.2	6.5	7.6	6.7
6900	4.9	5.7	7.5	6.8
7125	4.9	5.8	7.0	6.4

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Coordinate System for Radiation Pattern Visualization

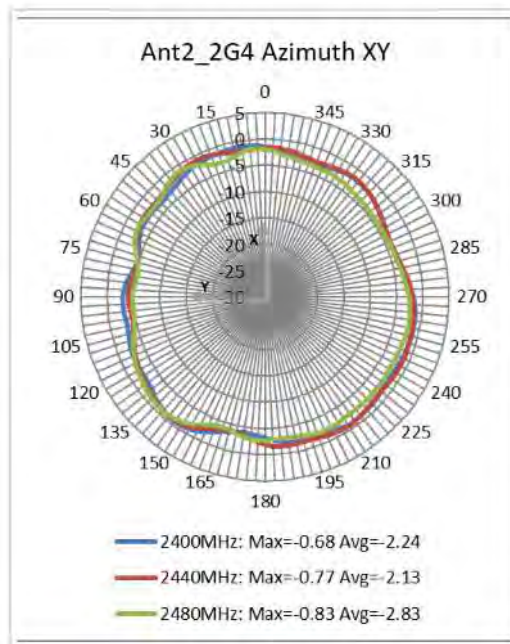


Orientation of EAI2620P

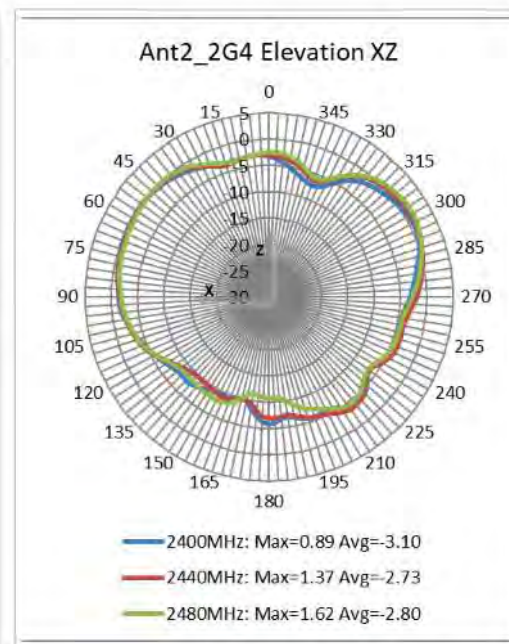
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9

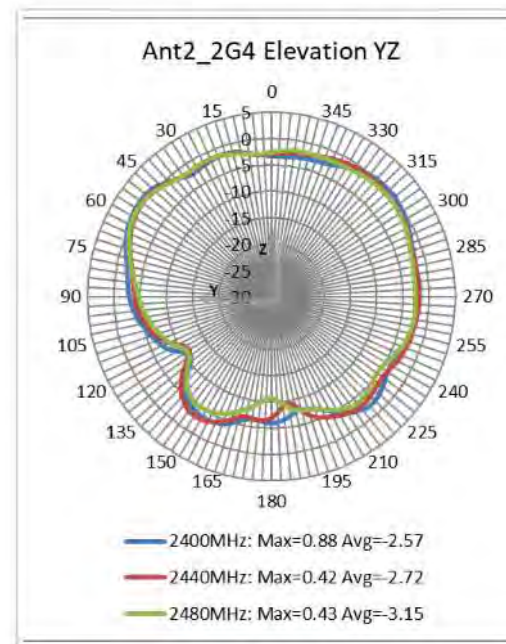
Total Gain Patterns: Ant2_2G4



Azimuth (XY)

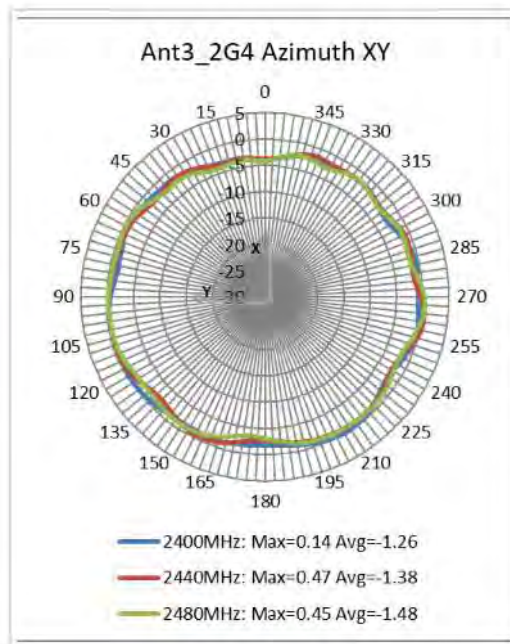


Side to Side (XZ)

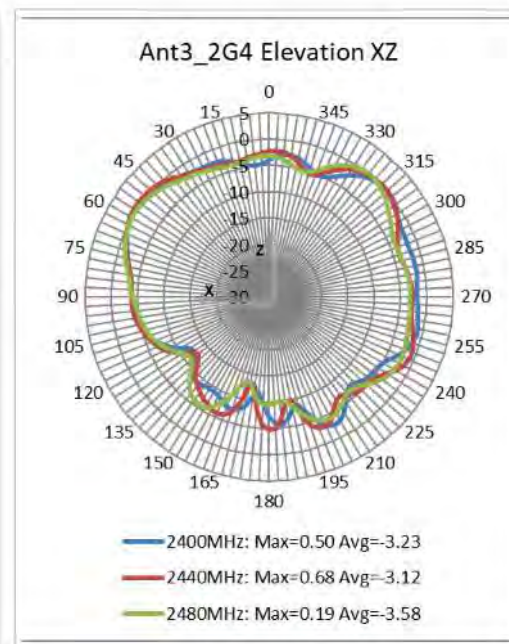


Front to Back (YZ)

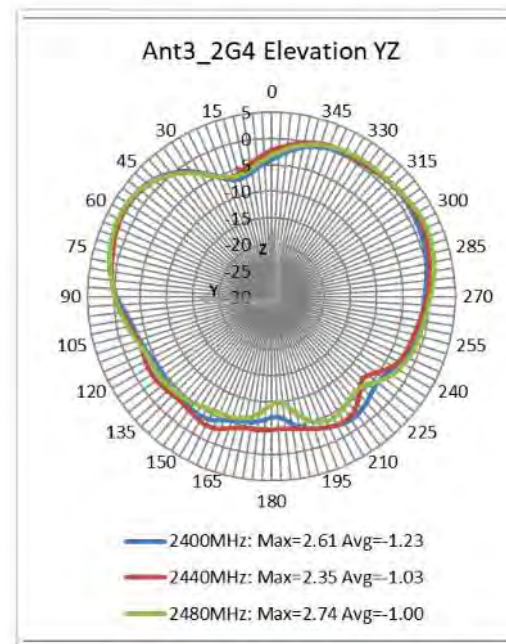
Total Gain Patterns: Ant3_2G4



Azimuth (XY)

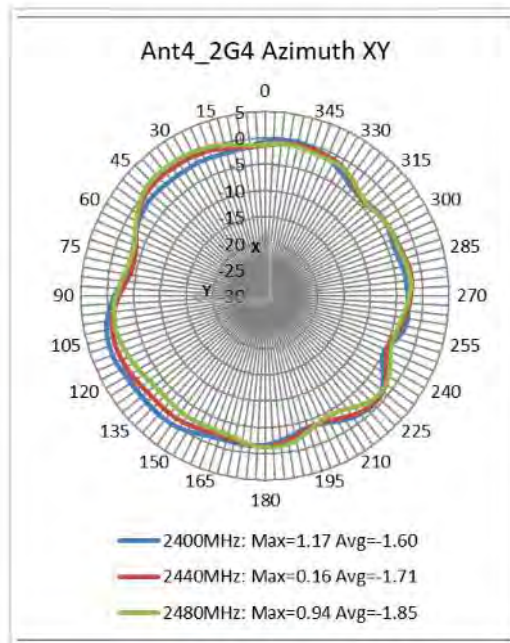


Side to Side (XZ)

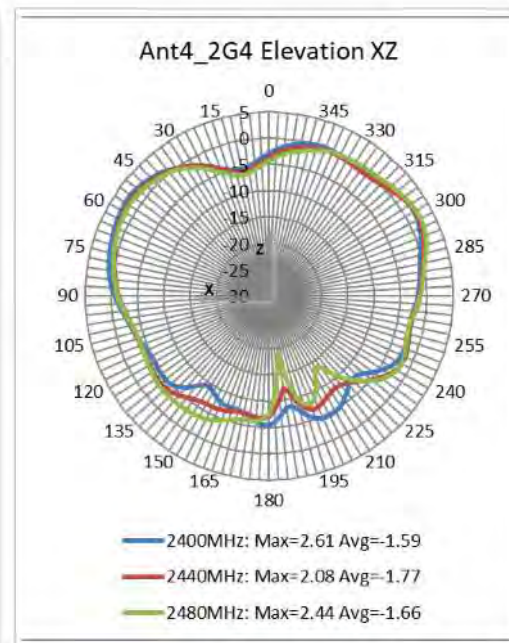


Front to Back (YZ)

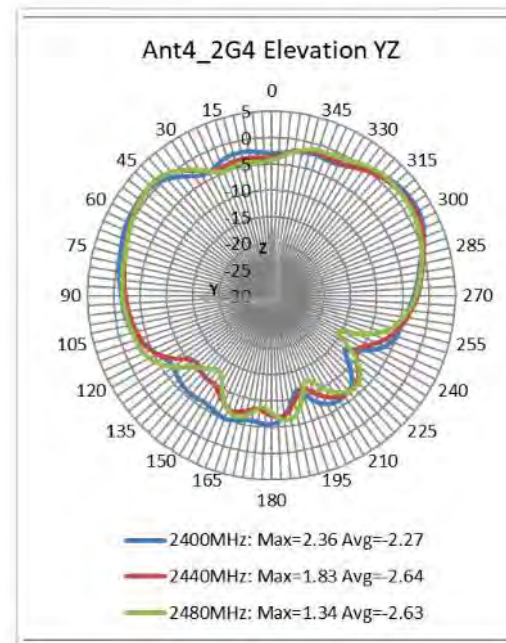
Total Gain Patterns: Ant4_2G4



Azimuth (XY)

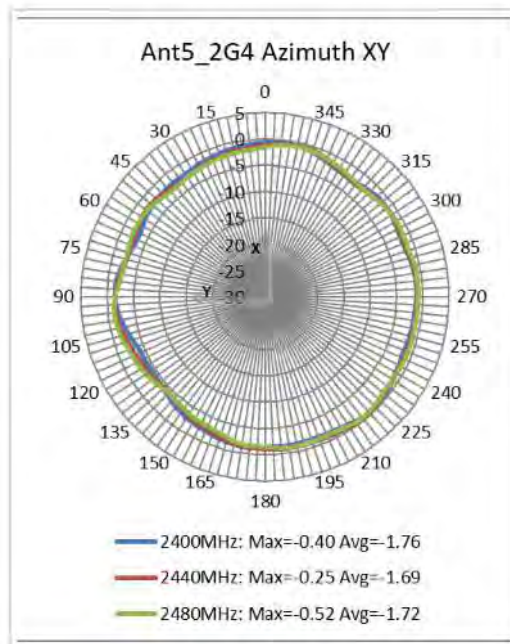


Side to Side (XZ)

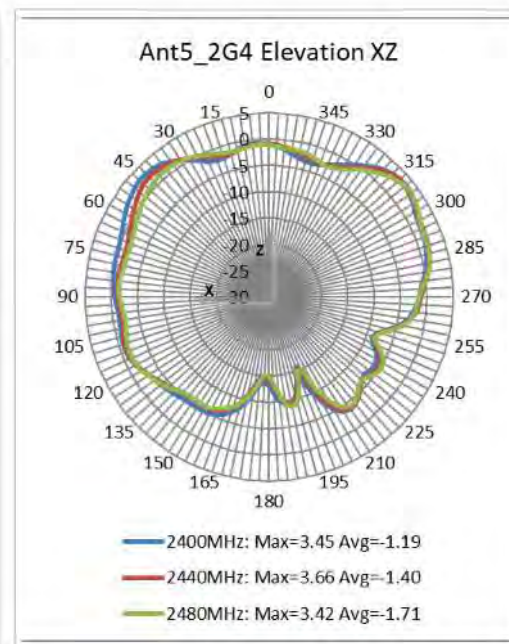


Front to Back (YZ)

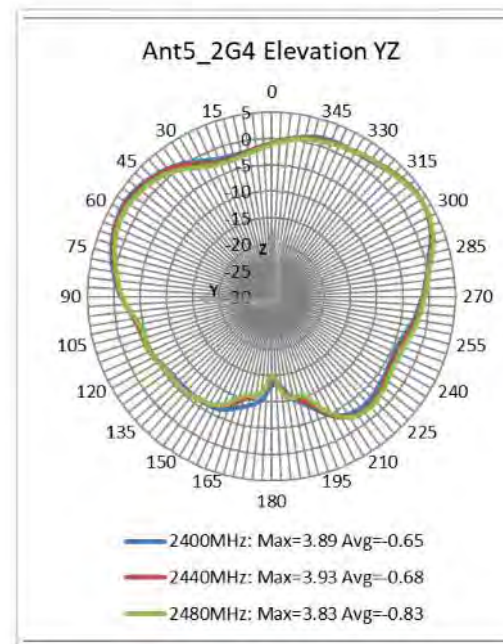
Total Gain Patterns: Ant5_2G4



Azimuth (XY)

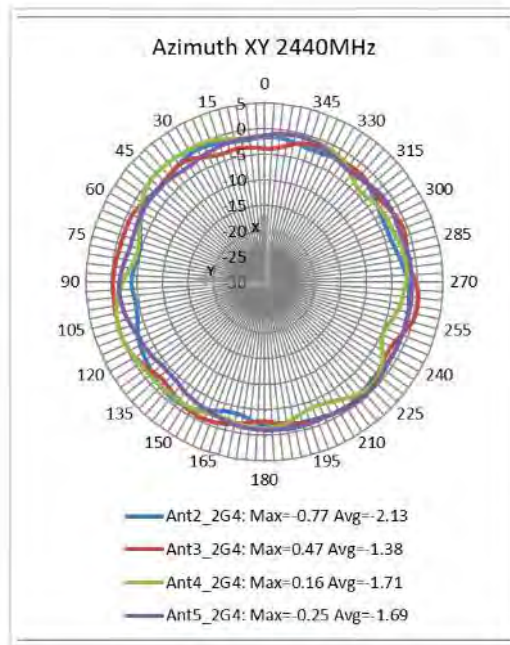


Side to Side (XZ)

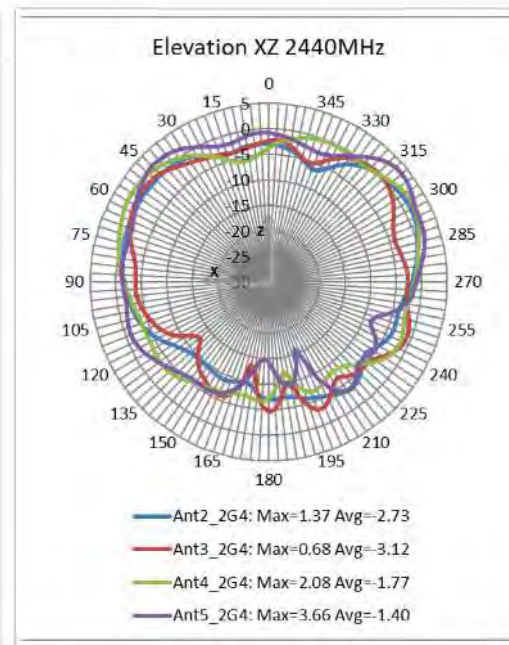


Front to Back (YZ)

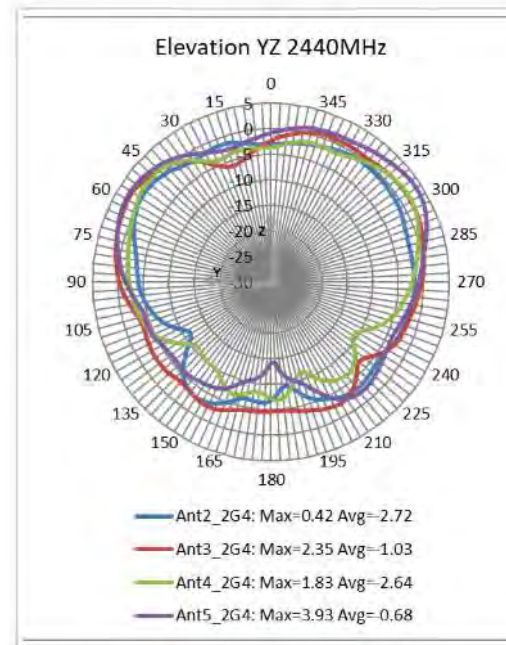
Coverage Total Gain Patterns: Wi-Fi Antennas at 2440MHz



Azimuth (XY)

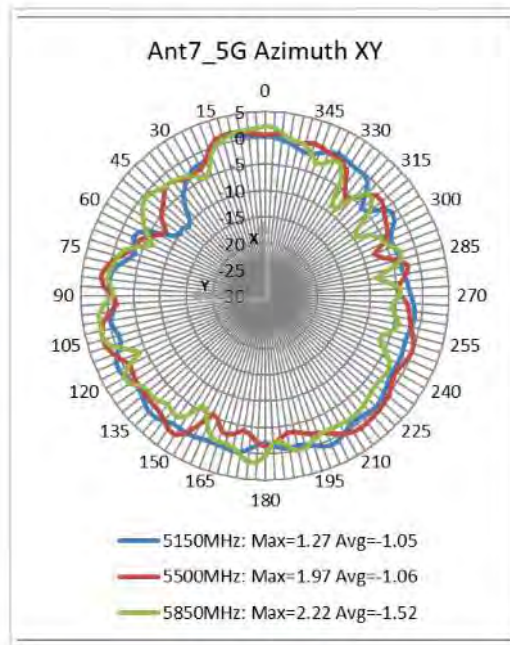


Side to Side (XZ)

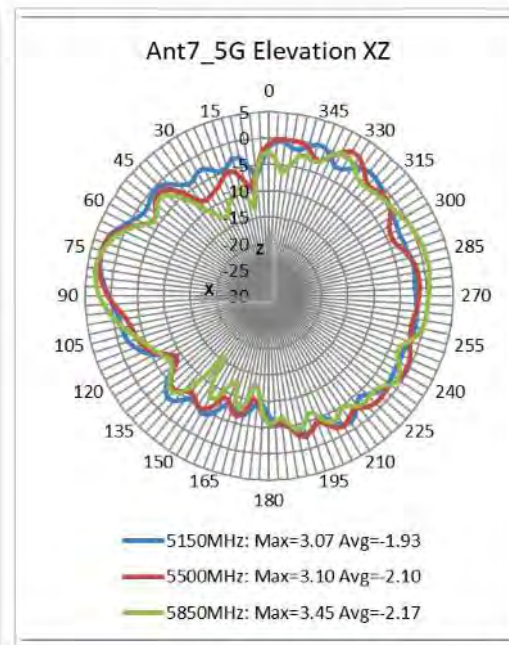


Front to Back (YZ)

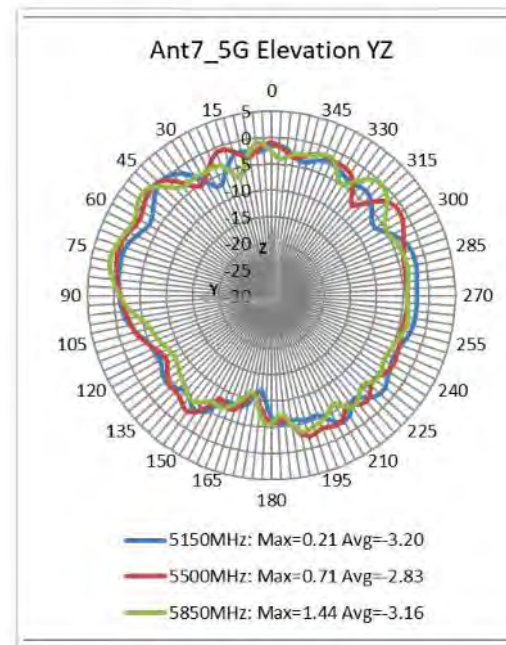
Total Gain Patterns: Ant7_5G



Azimuth (XY)

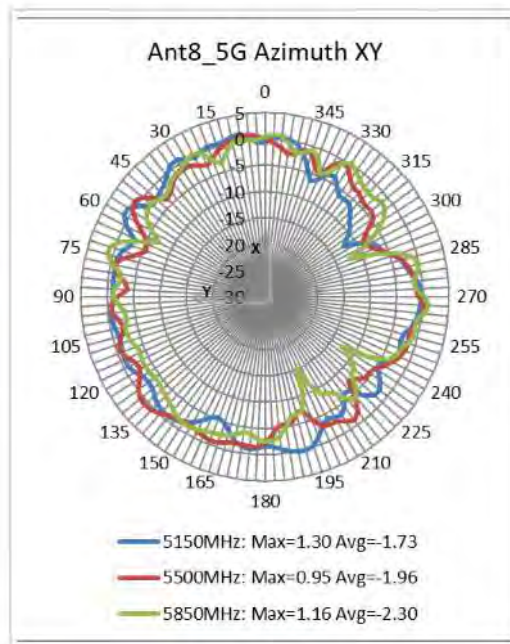


Side to Side (XZ)

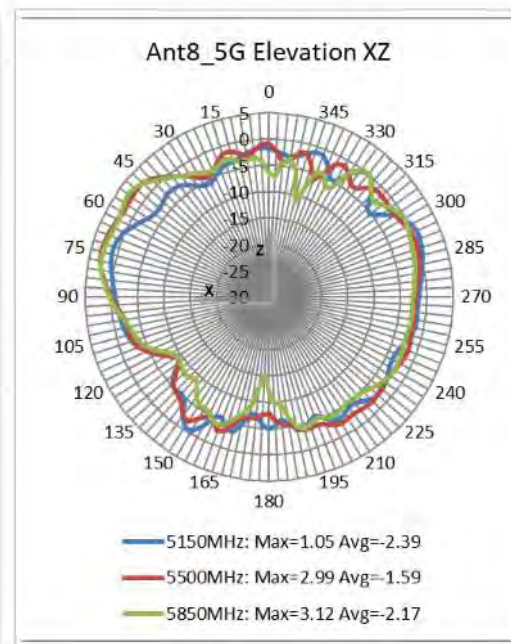


Front to Back (YZ)

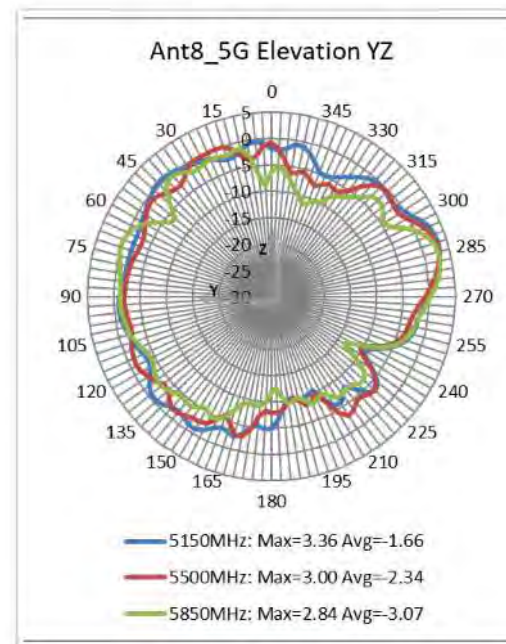
Total Gain Patterns: Ant8_5G



Azimuth (XY)

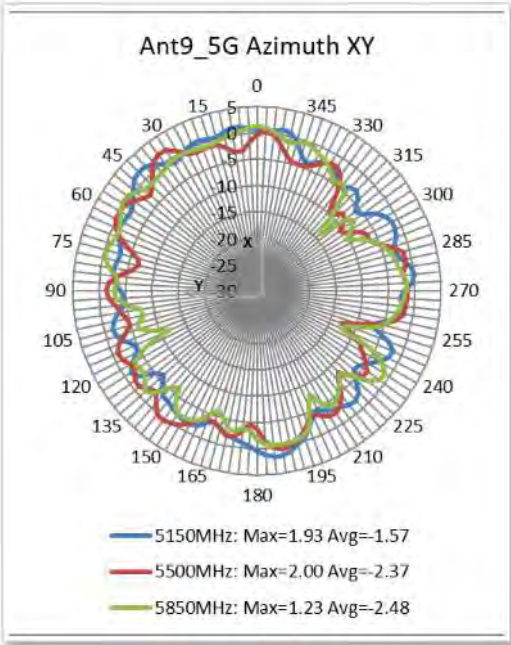


Side to Side (XZ)

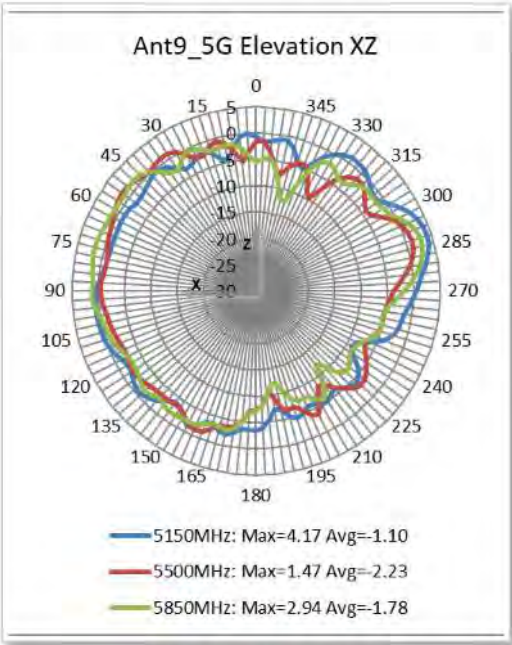


Front to Back (YZ)

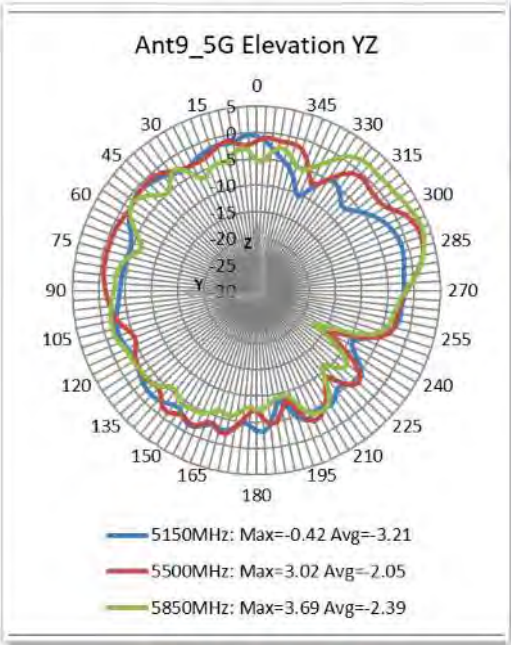
Total Gain Patterns: Ant9_5G



Azimuth (XY)

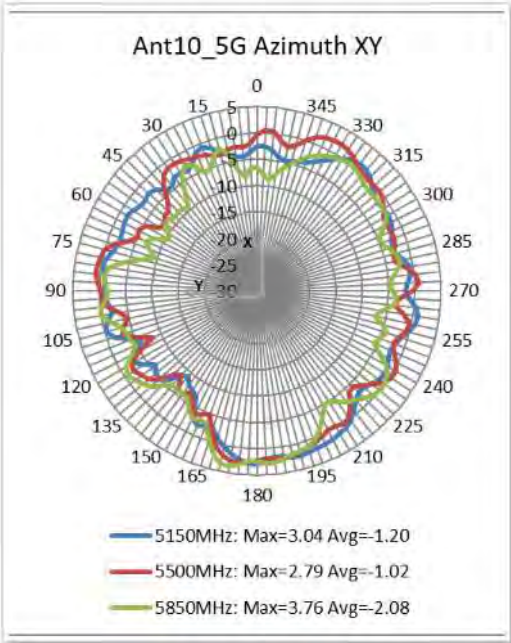


Side to Side (XZ)

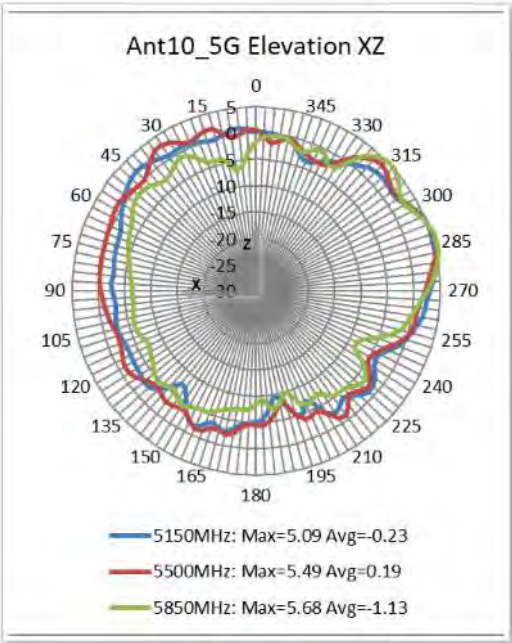


Front to Back (YZ)

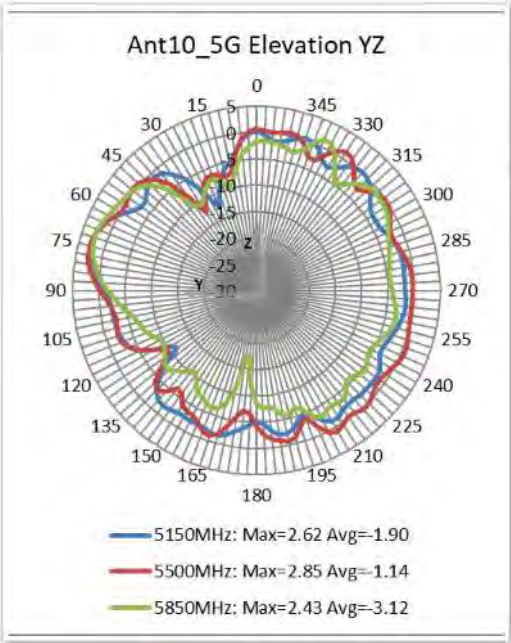
Total Gain Patterns: Ant10_5G



Azimuth (XY)

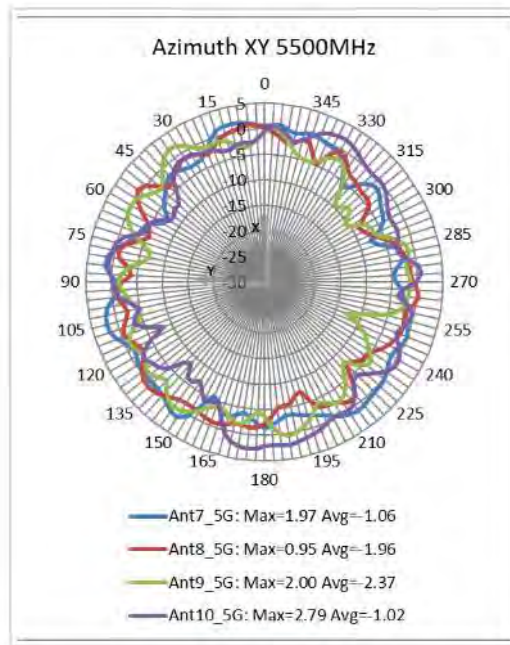


Side to Side (XZ)

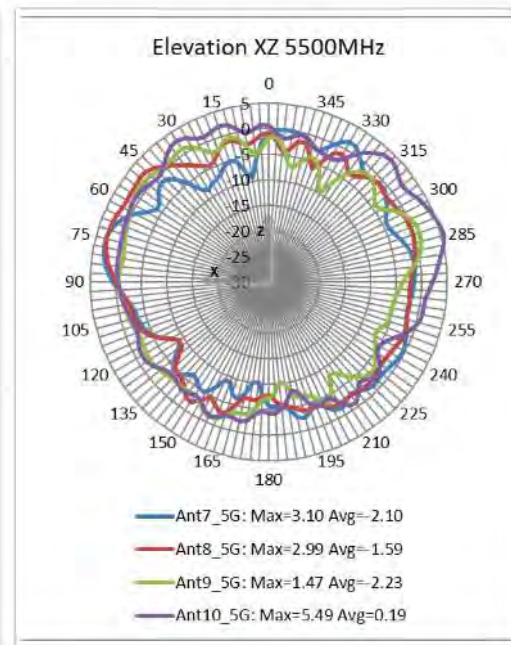


Front to Back (YZ)

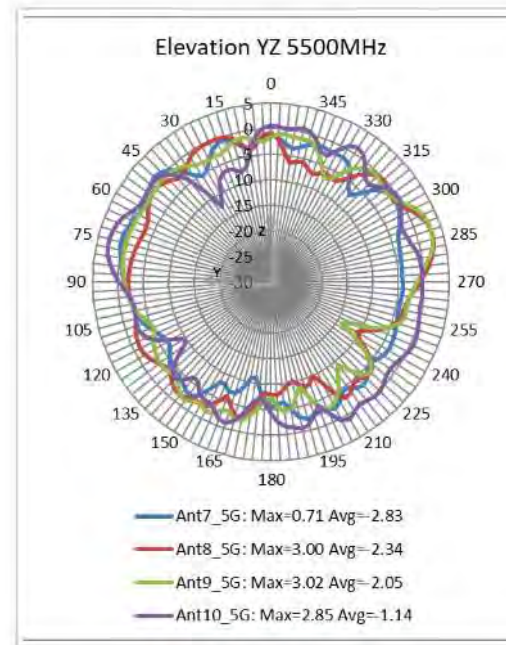
Coverage Total Gain Patterns: Wi-Fi Antennas at 5500MHz



Azimuth (XY)

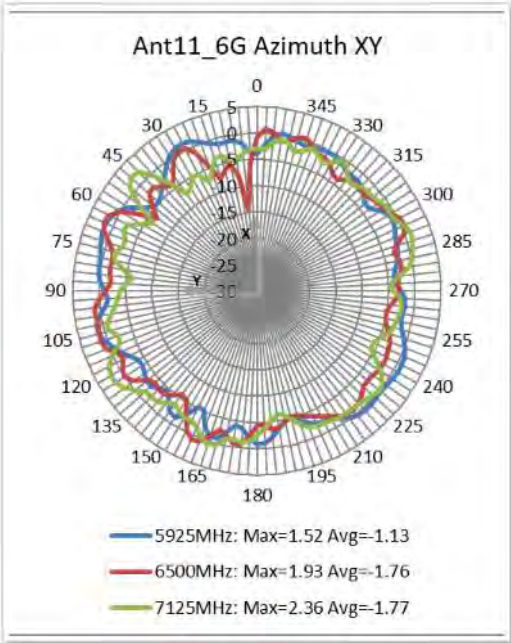


Side to Side (XZ)

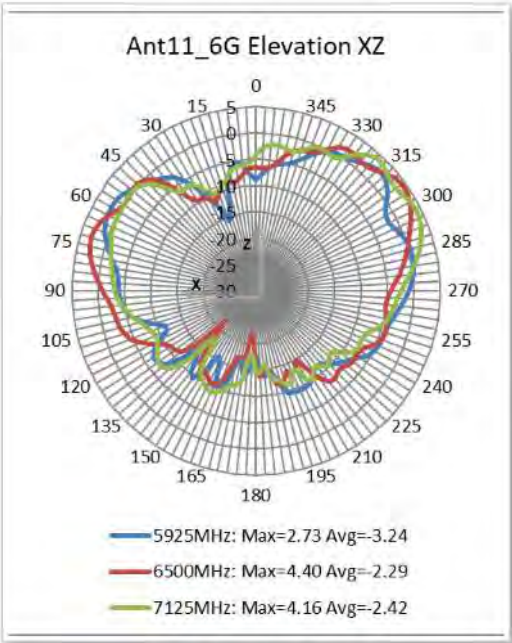


Front to Back (YZ)

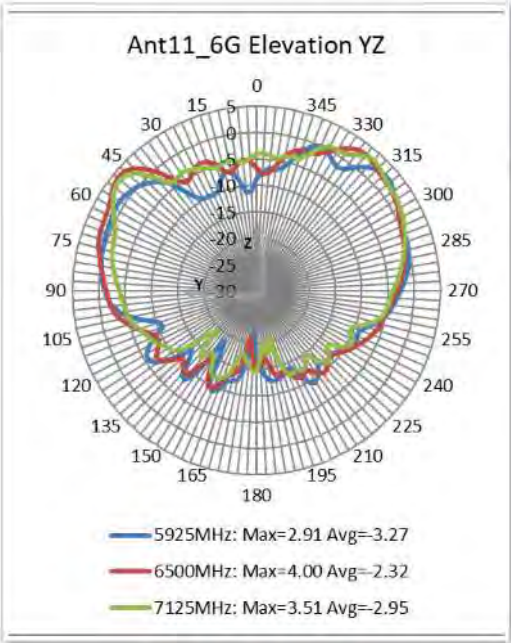
Total Gain Patterns: Ant11_6G



Azimuth (XY)

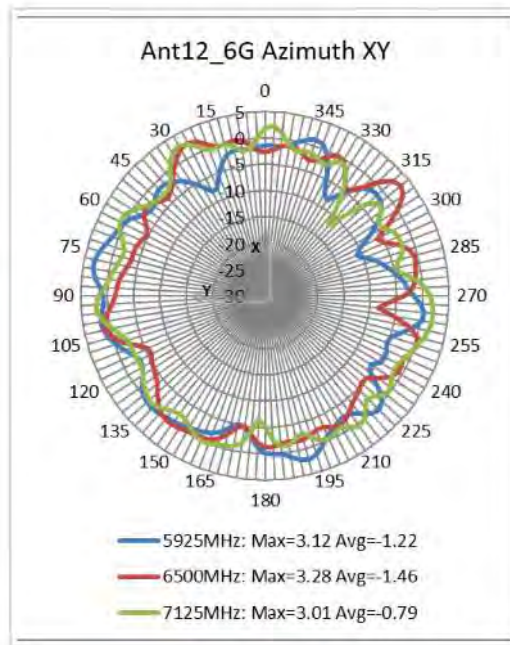


Side to Side (XZ)

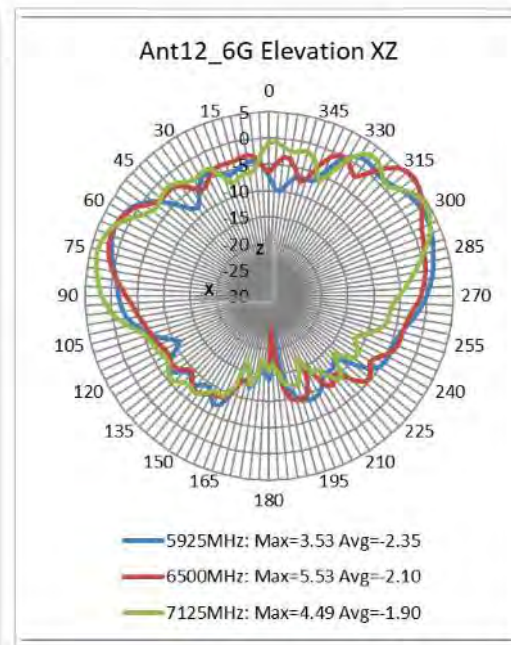


Front to Back (YZ)

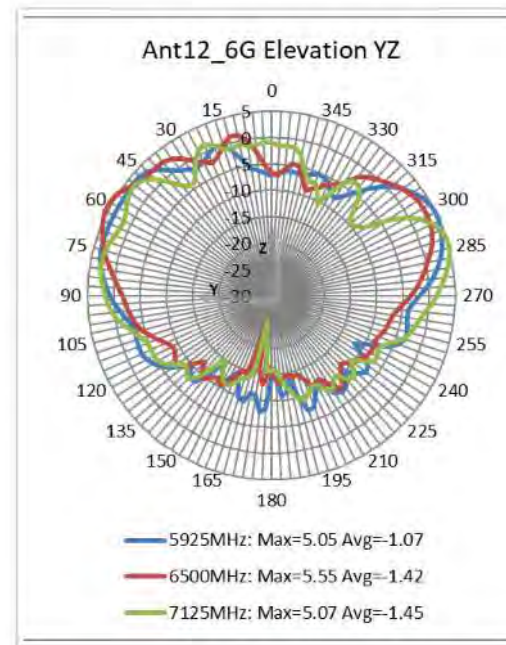
Total Gain Patterns: Ant12_6G



Azimuth (XY)

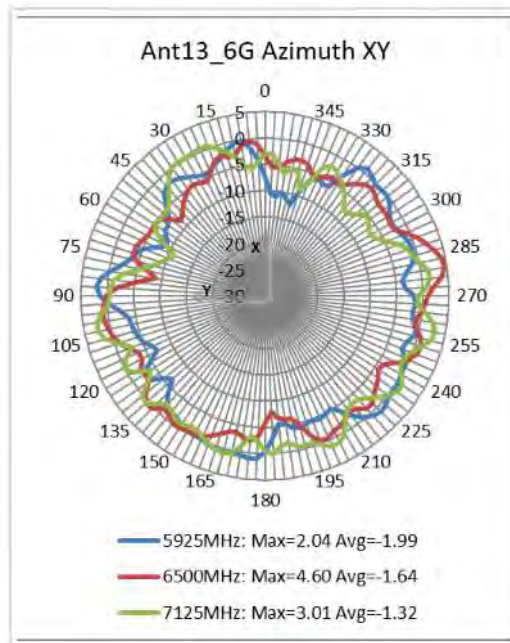


Side to Side (XZ)

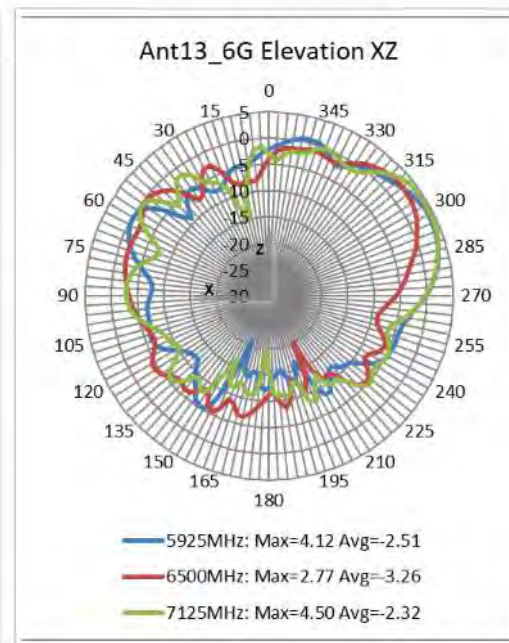


Front to Back (YZ)

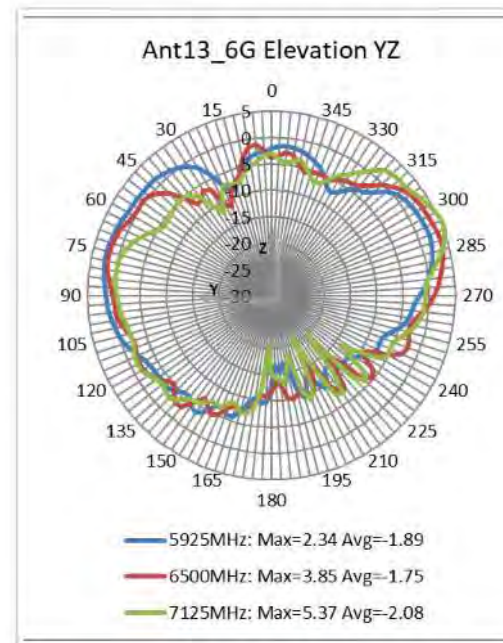
Total Gain Patterns: Ant13_6G



Azimuth (XY)

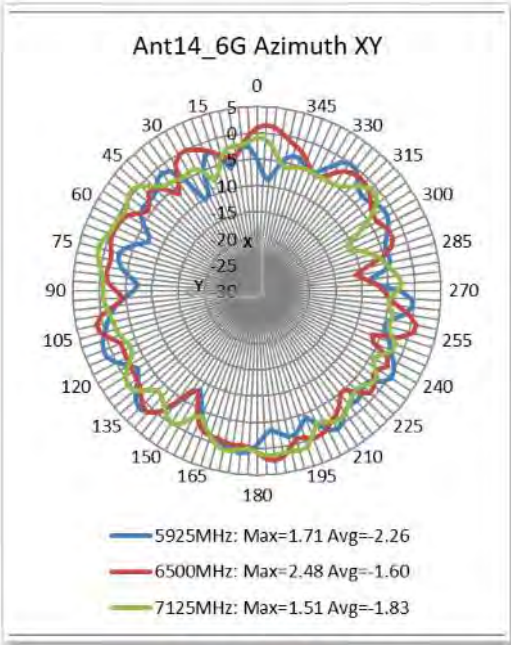
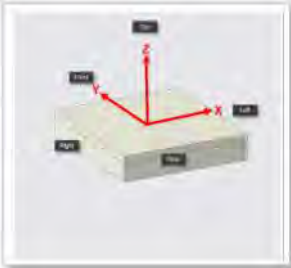


Side to Side (XZ)

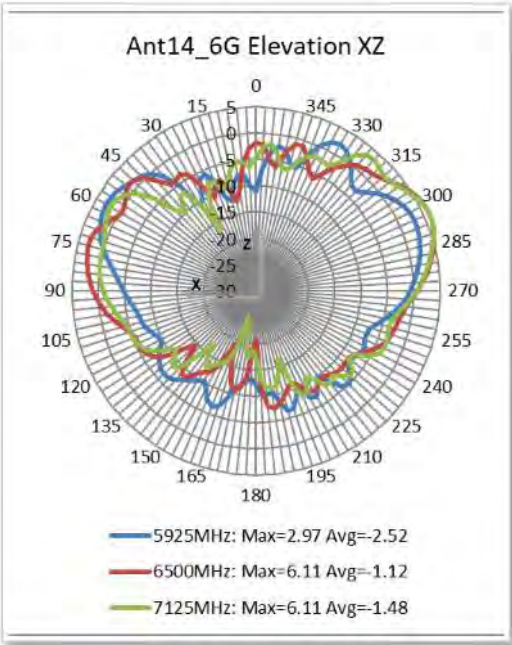


Front to Back (YZ)

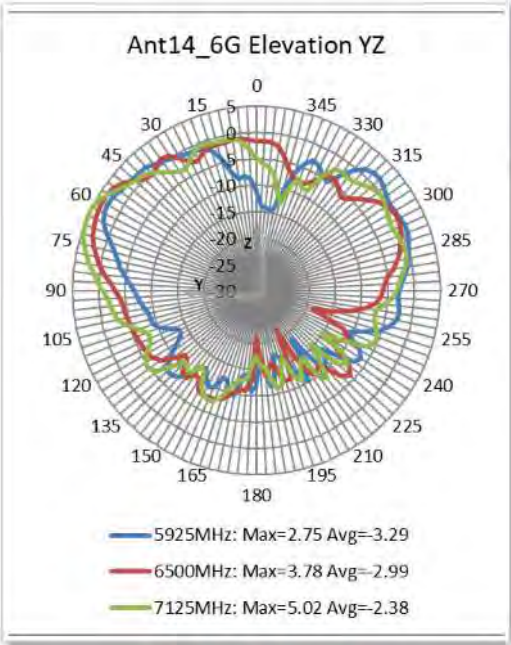
Total Gain Patterns: Ant14_6G



Azimuth (XY)

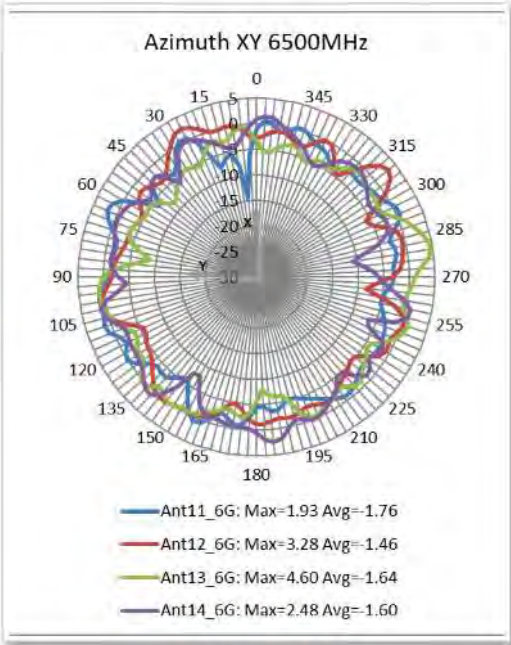


Side to Side (XZ)

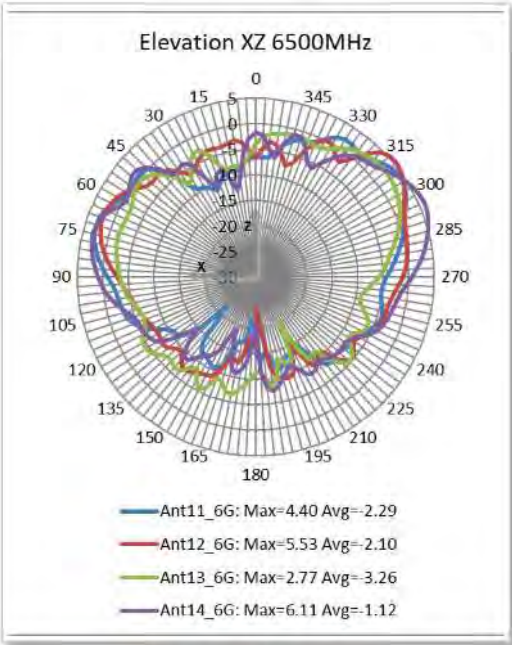


Front to Back (YZ)

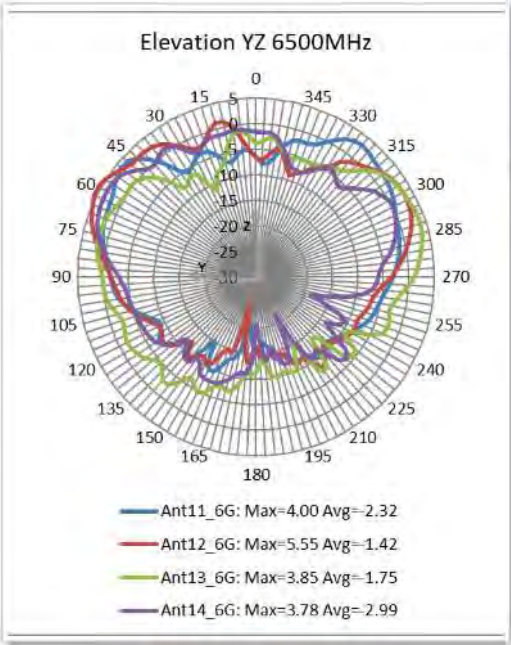
Coverage Total Gain Patterns: Wi-Fi Antennas at 6500MHz



Azimuth (XY)



Side to Side (XZ)

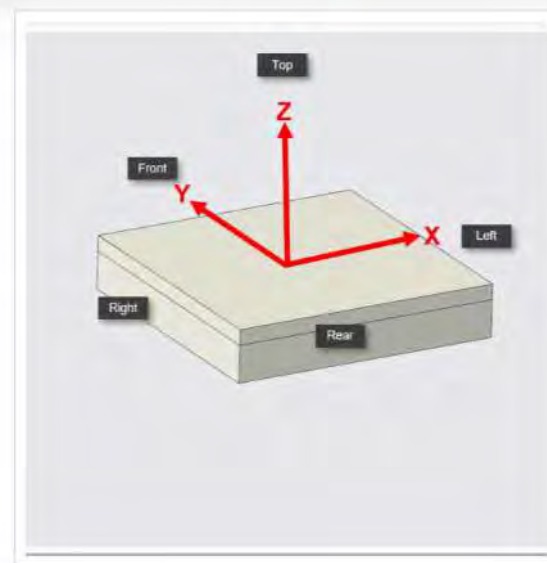
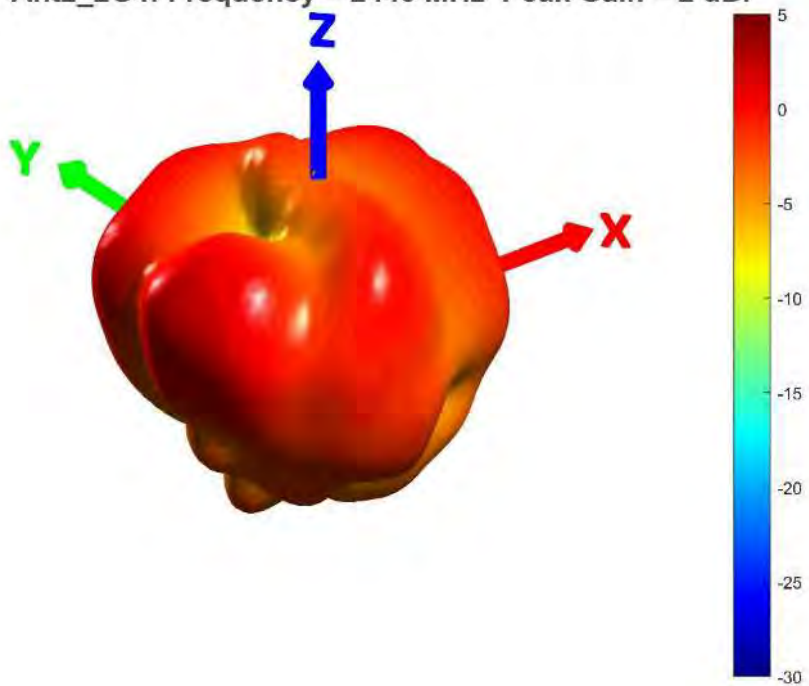


Front to Back (YZ)

Total Gain 3D Pattern: Ant2_2G4 at 2440MHz



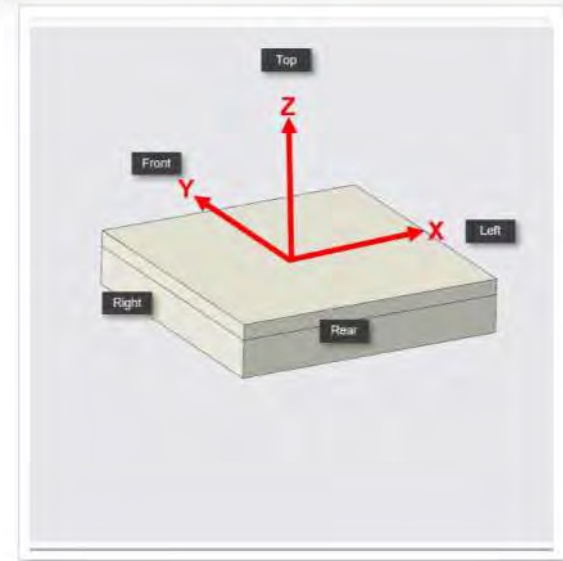
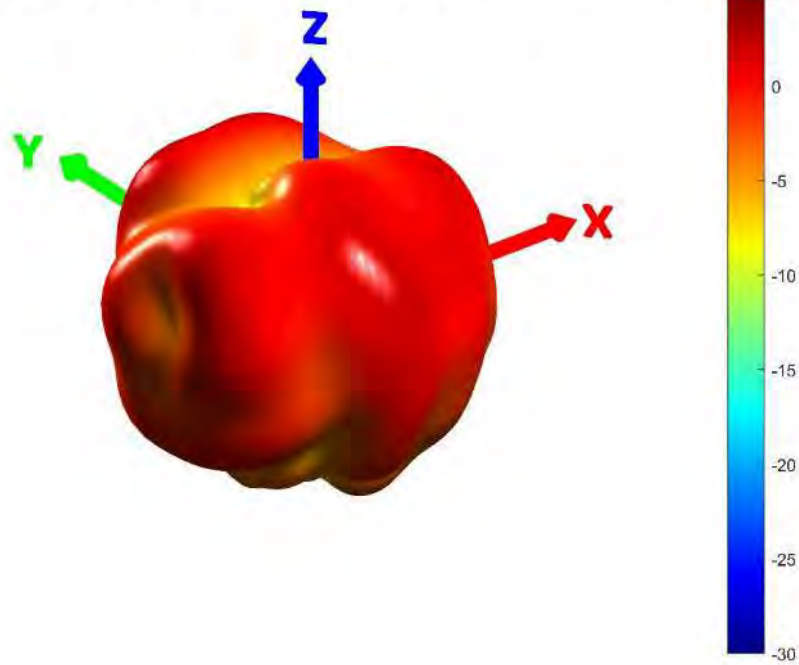
EAI2620P Ant2_2G4: Frequency = 2440 MHz Peak Gain = 2 dBi



Total Gain 3D Pattern: Ant3_2G4 at 2440MHz



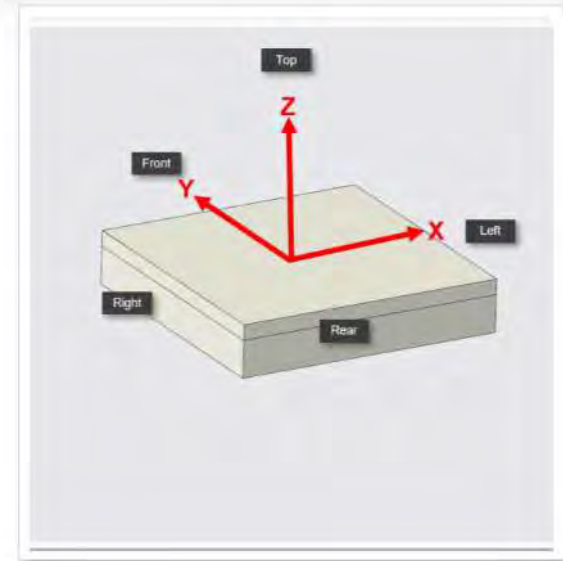
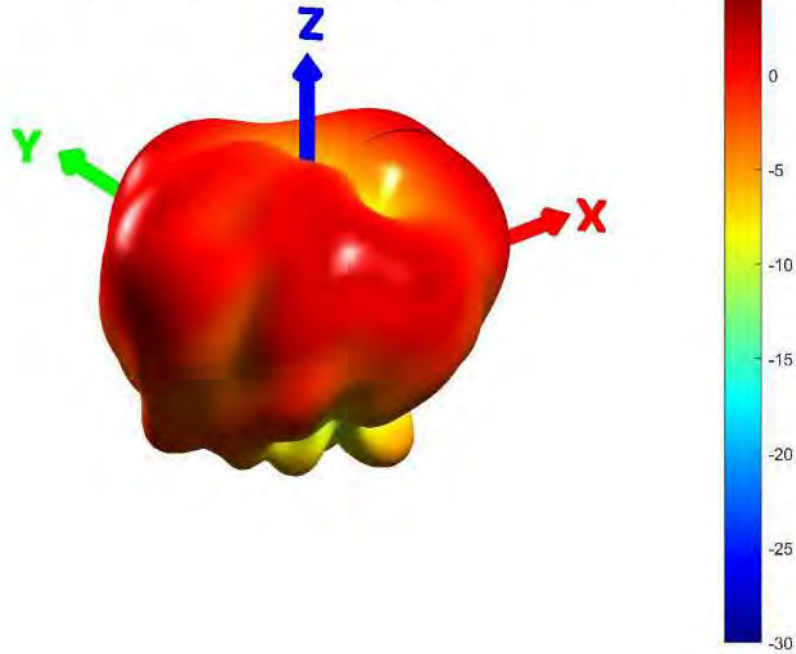
EAI2620P Ant3_2G4: Frequency = 2440 MHz Peak Gain = 3.5 dBi



Total Gain 3D Pattern: Ant4_2G4 at 2440MHz



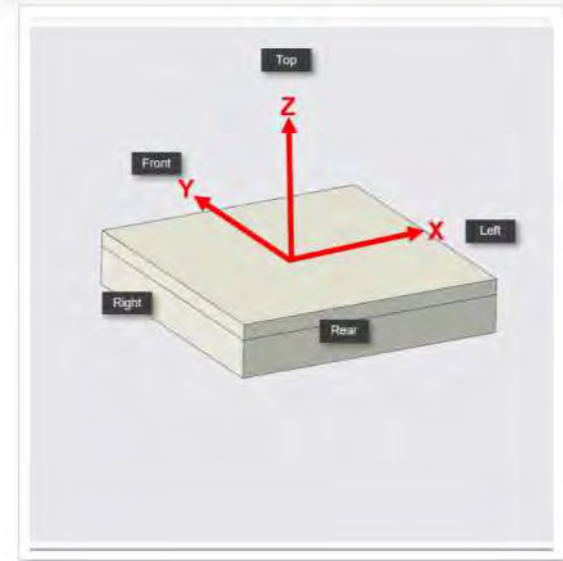
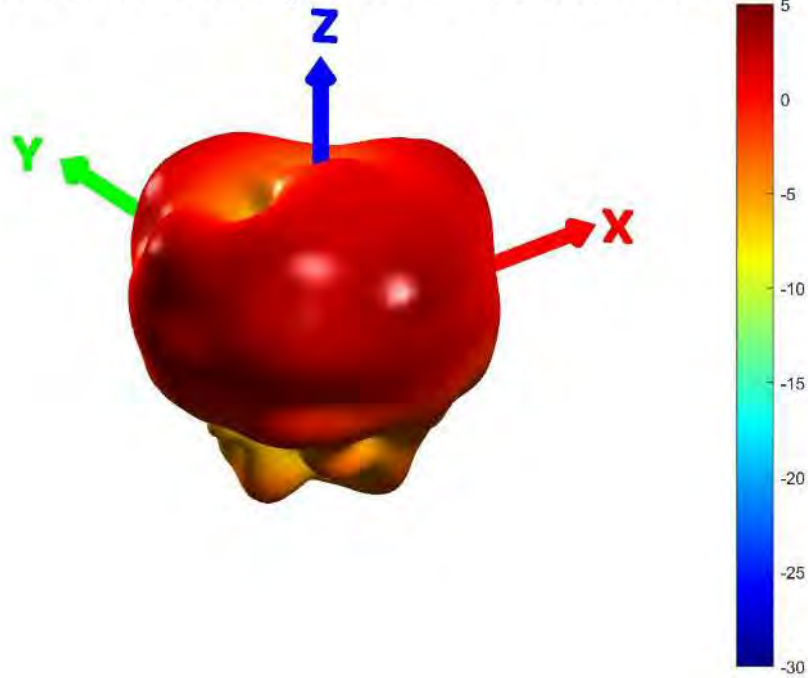
EAI2620P Ant4_2G4: Frequency = 2440 MHz Peak Gain = 2.5 dBi



Total Gain 3D Pattern: Ant5_2G4 at 2440MHz



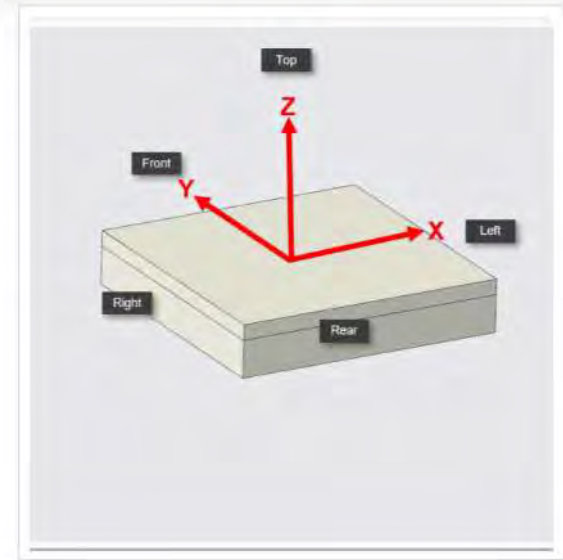
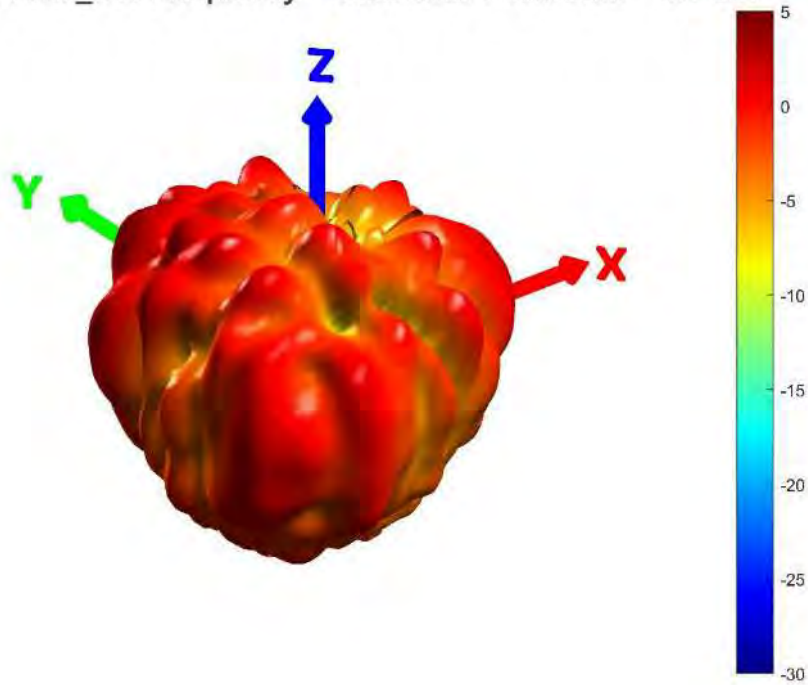
EAI2620P Ant5_2G4: Frequency = 2440 MHz Peak Gain = 4.2 dBi



Total Gain 3D Pattern: Ant7_5G at 5500MHz



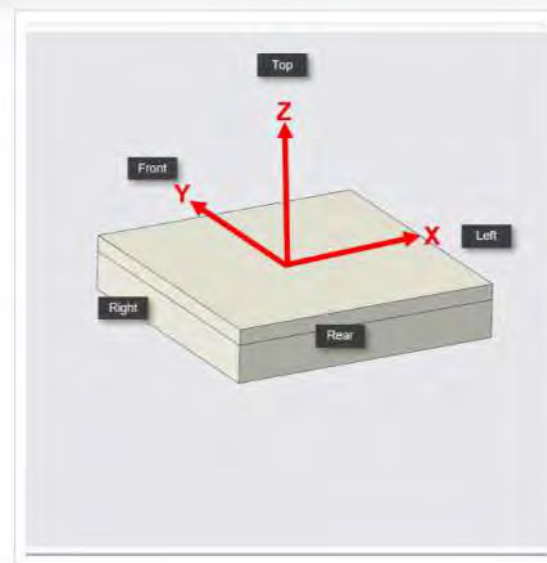
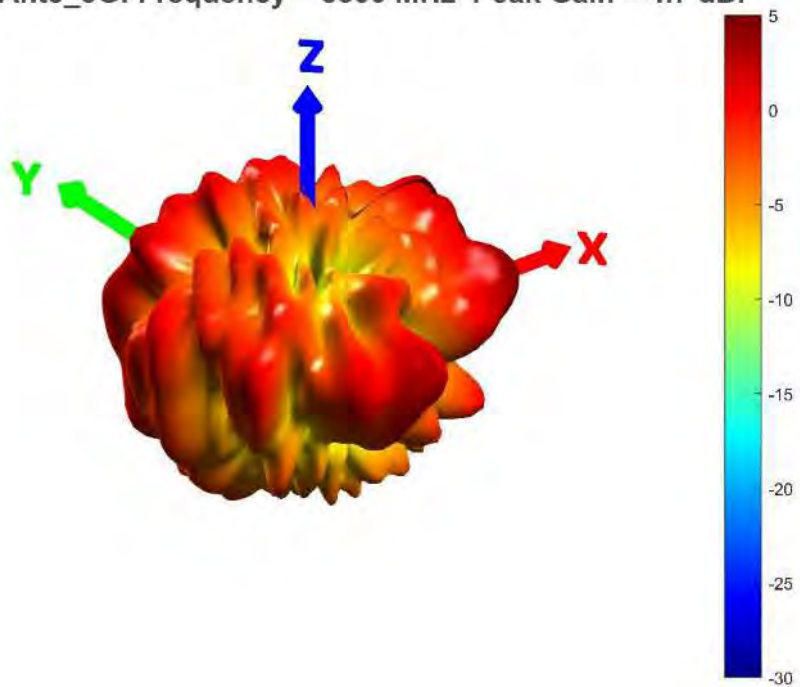
EAI2620P Ant7_5G: Frequency = 5500 MHz Peak Gain = 4.1 dBi



Total Gain 3D Pattern: Ant8_5G at 5500MHz



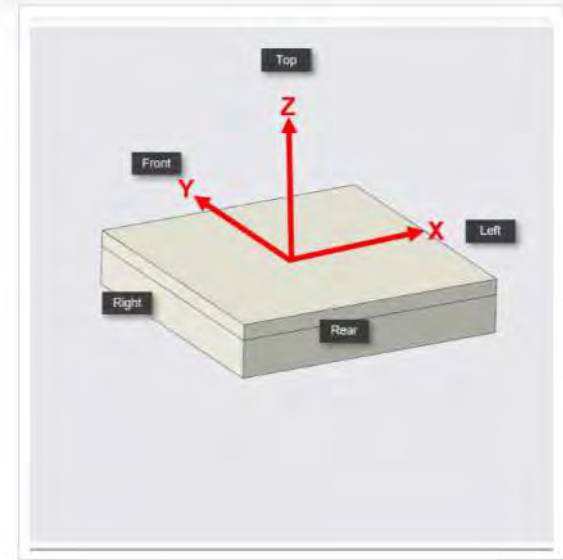
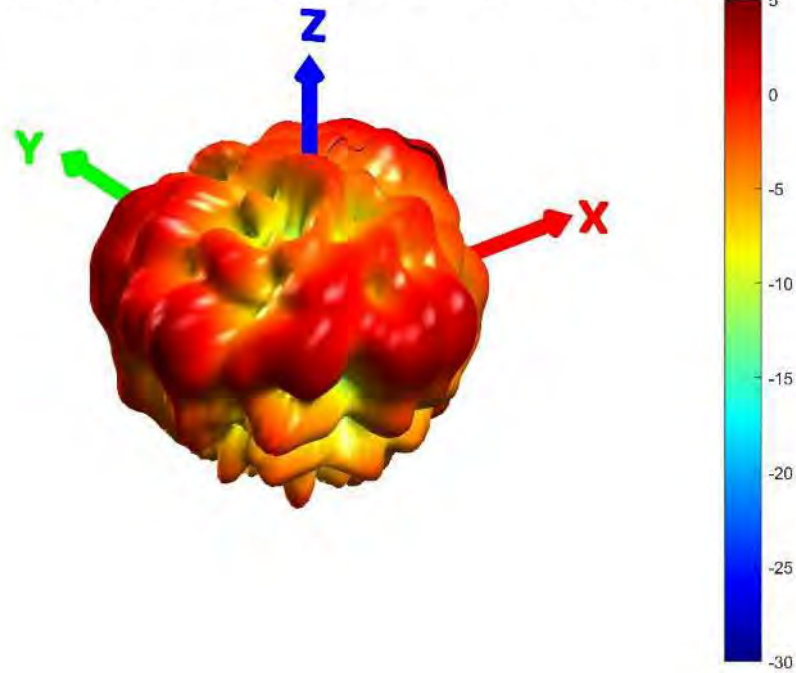
EAI2620P Ant8_5G: Frequency = 5500 MHz Peak Gain = 4.7 dBi



Total Gain 3D Pattern: Ant9_5G at 5500MHz



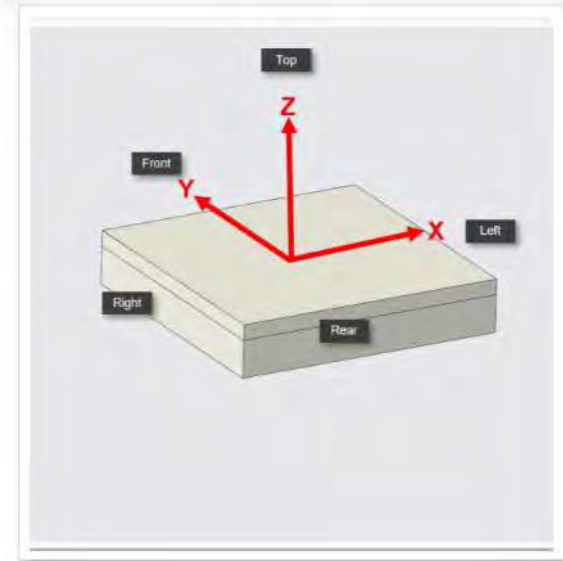
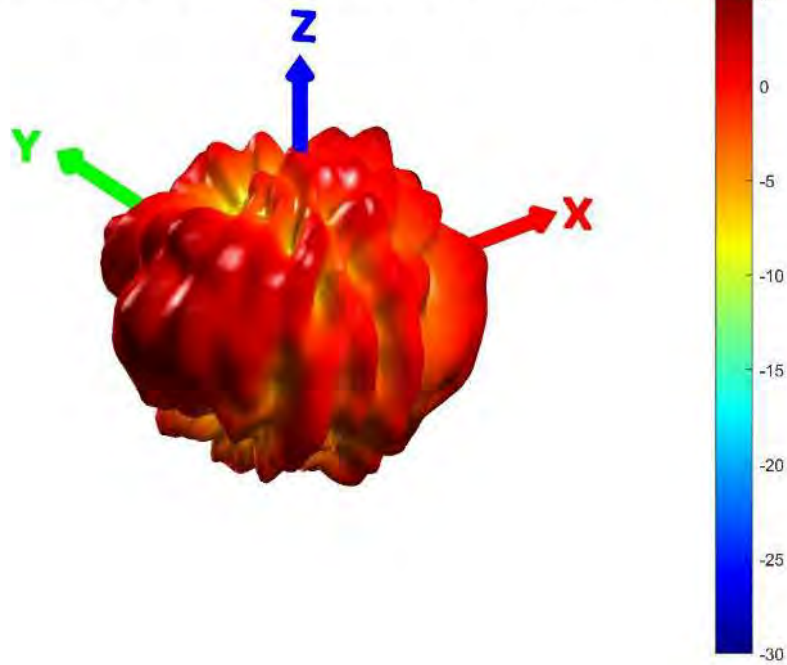
EAI2620P Ant9_5G: Frequency = 5500 MHz Peak Gain = 4 dBi



Total Gain 3D Pattern: Ant10_5G at 5500MHz



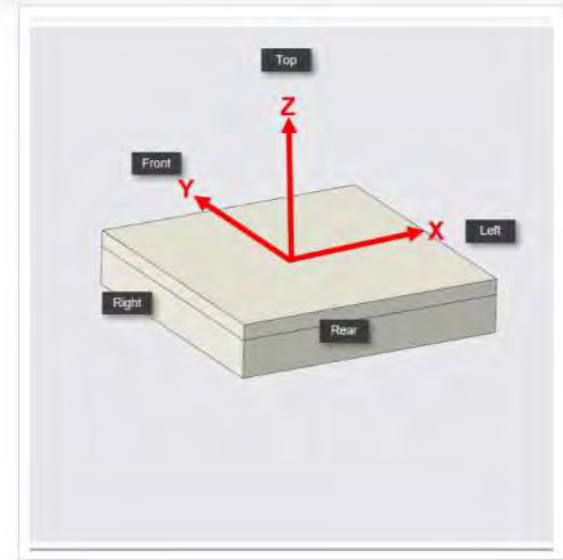
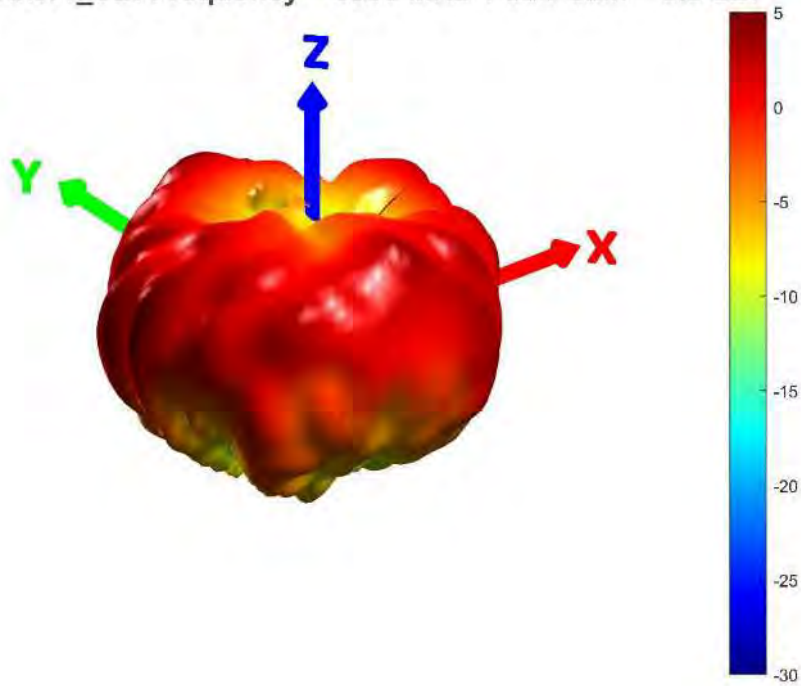
EAI2620P Ant10_5G: Frequency = 5500 MHz Peak Gain = 5.5 dBi



Total Gain 3D Pattern: Ant11_6G at 6500MHz



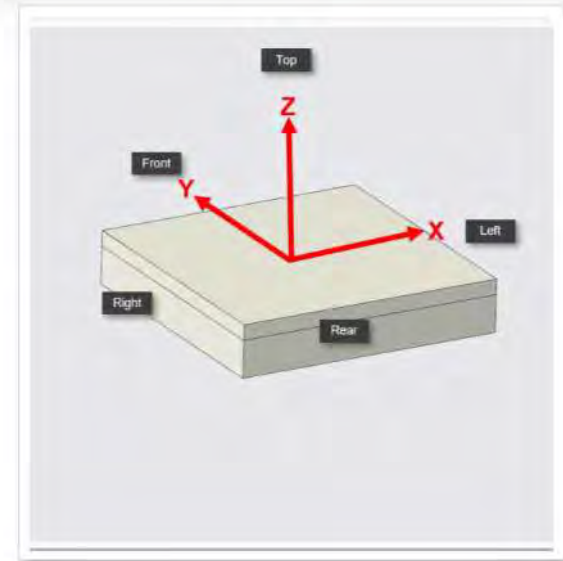
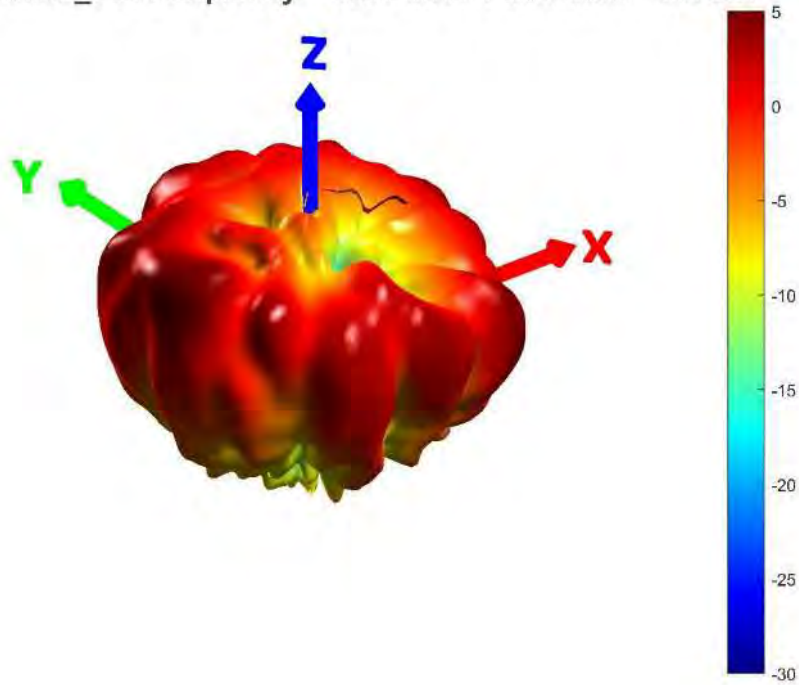
EAI2620P Ant11_6G: Frequency = 6500 MHz Peak Gain = 5.3 dBi



Total Gain 3D Pattern: Ant12_6G at 6500MHz



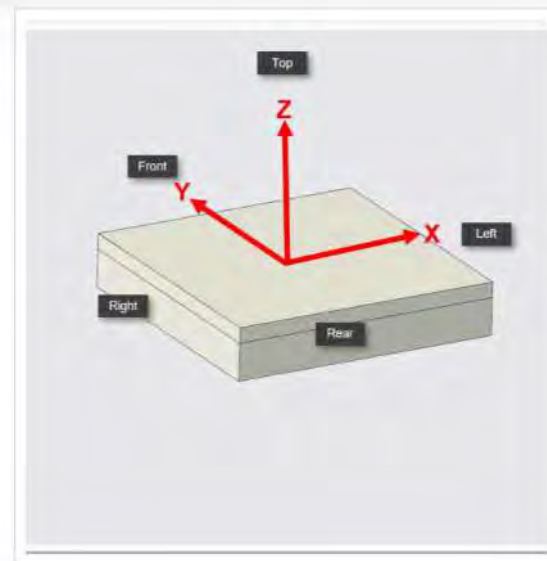
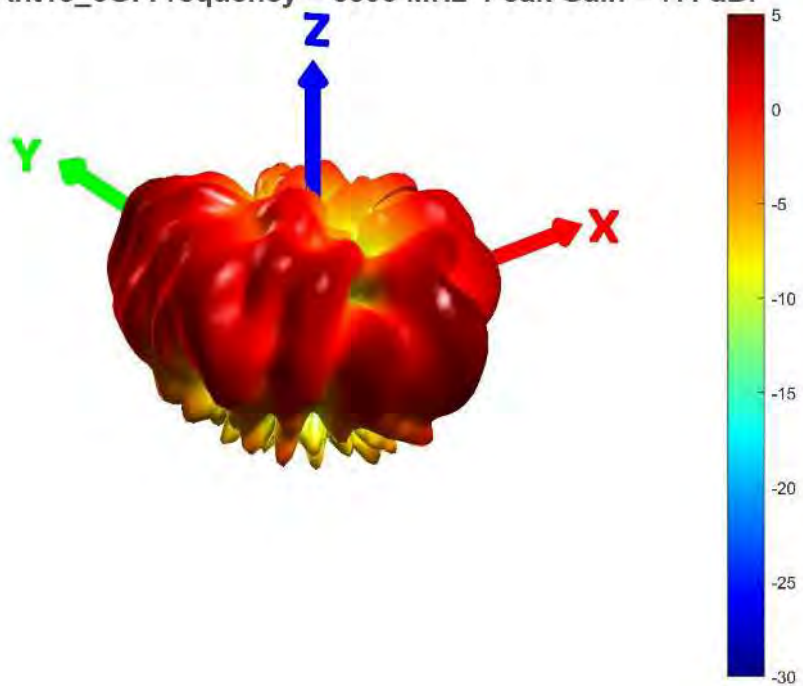
EAI2620P Ant12_6G: Frequency = 6500 MHz Peak Gain = 6.2 dBi



Total Gain 3D Pattern: Ant13_6G at 6500MHz



EAI2620P Ant13_6G: Frequency = 6500 MHz Peak Gain = 7.4 dBi



Total Gain 3D Pattern: Ant14_6G at 6500MHz



EAI2620P Ant14_6G: Frequency = 6500 MHz Peak Gain = 6.7 dBi

