



Customer Name & Project: EAI2308P

Prepared By: Terry Tao

Test Date: 24th Aug 2022

Report release Date: 25th Aug 2022

Airgain, Inc.

•3611 Valley Centre Drive, Ste. 150

San Diego, CA 92130 USA

•+1 760 579 0200

•+1 760 579 0892

- Airgain proposes an embedded antenna solution for EAI2308P
 - **The antenna solution is updated based upon the latest 3D provided customer**

- The solution for this device is as follows:
 - **Cable-fed Antennas:**
 - 1 pcs 2.4G&5G Antennas(2.4GHz-2.49GHz,5.15GHz-5.85GHz)
 - 4 pcs 2G Antennas(2.4GHz-2.49GHz)
 - 4 pcs 6G Antennas(5.925GHz-7.125GHz)
 - 4 pcs 5G Antennas(5.15GHz-5.85GHz)
 - 1 pcs BT Antenna (2.4GHz-2.49GHz)
- 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

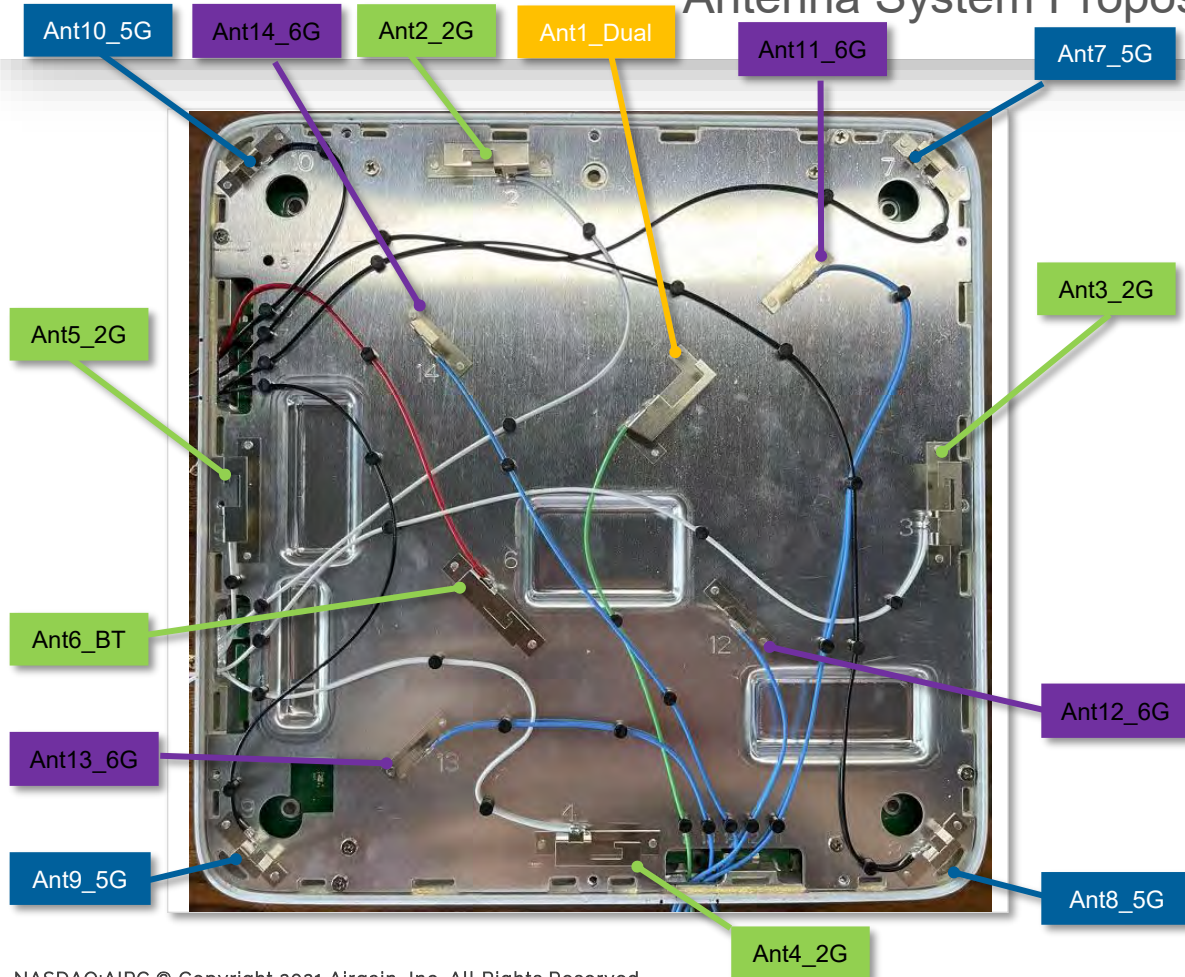
Summary of Requirements



- 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

Antenna System Proposal



Antenna #	Part Number	Type
Ant1_Dual	M03AKAFB	FR4, Cable fed
Ant2_2G	M01AKAFC	FR4, Cable fed
Ant3_2G	M01AKAFC	FR4, Cable fed
Ant4_2G	M01AKAFC	FR4, Cable fed
Ant5_2G	M01AKAFC	FR4, Cable fed
Ant6_BT	M01AKAFC	FR4, Cable fed
Ant7_5G	M02AKAFD	FR4, Cable fed
Ant8_5G	M02AKAFD	FR4, Cable fed
Ant9_5G	M02AKAFD	FR4, Cable fed
Ant10_5G	M02AKAFD	FR4, Cable fed
Ant11_6G	M02AKAFF	FR4, Cable fed
Ant12_6G	M02AKAFF	FR4, Cable fed
Ant13_6G	M02AKAFF	FR4, Cable fed
Ant14_6G	M02AKAFF	FR4, Cable fed

S-Parameters

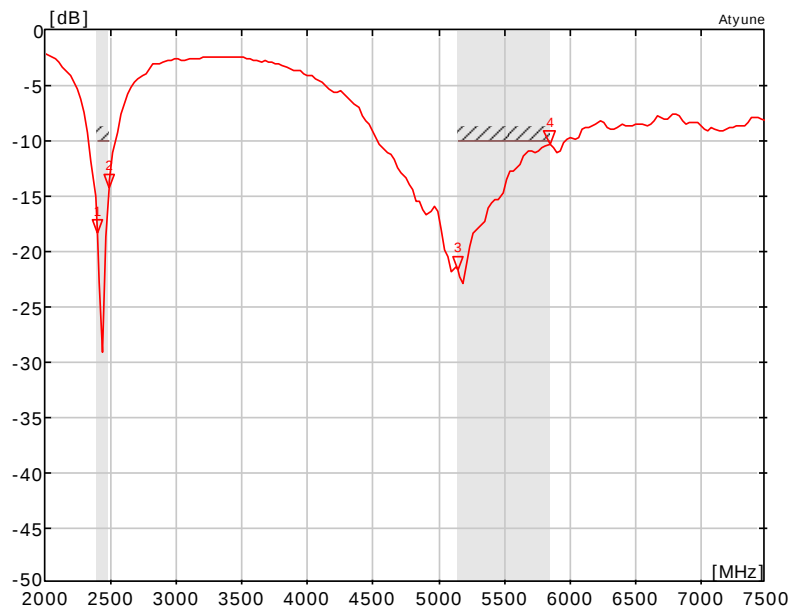
Actual Equipment List and Calibration Information



Vendor	Model	Calibrated Date	Calibrated Until
Agilent Technologies	E5071B	2021/8/26	2022/8/25

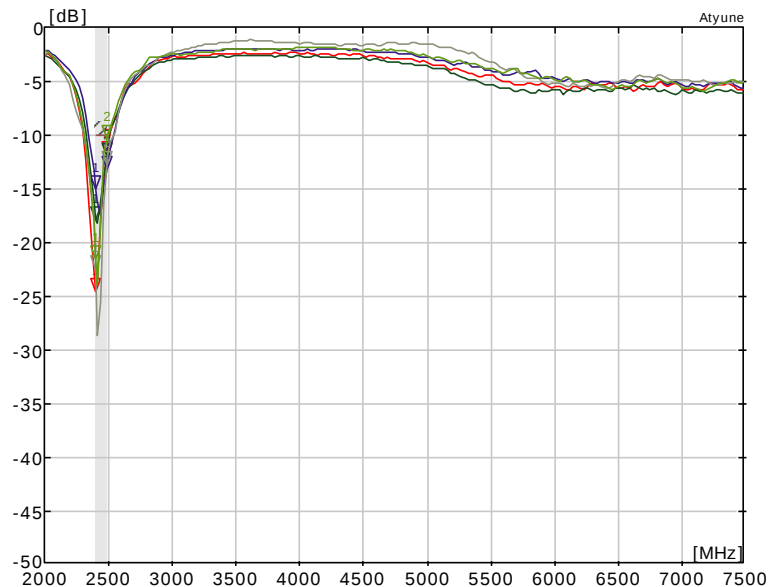


S-Parameter – Return Loss for Dual-band



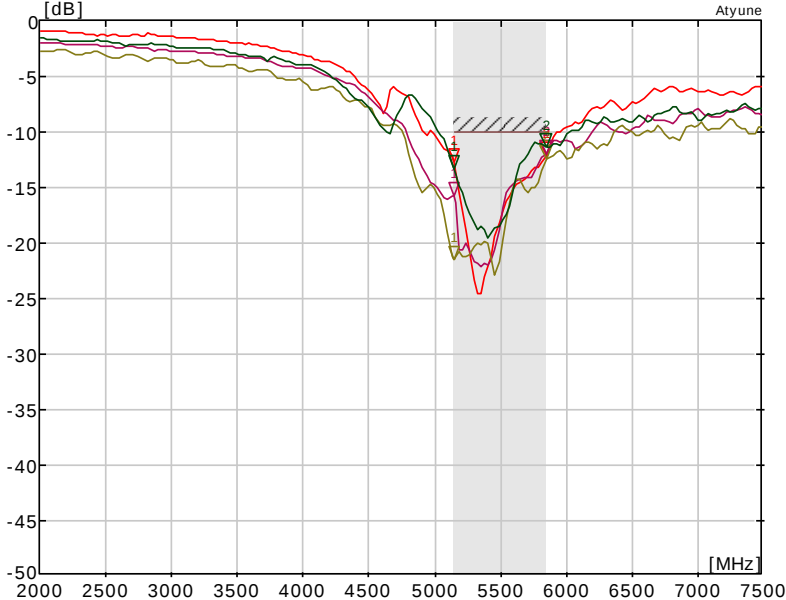
MARKERS:	MHz	dB	MHz	dB
A1				
—	1: 2400	-18.32	3: 5150	-21.61
	2: 2490	-14.13	4: 5850	-10.26

S-Parameter – Return Loss for 2G&BT Antennas



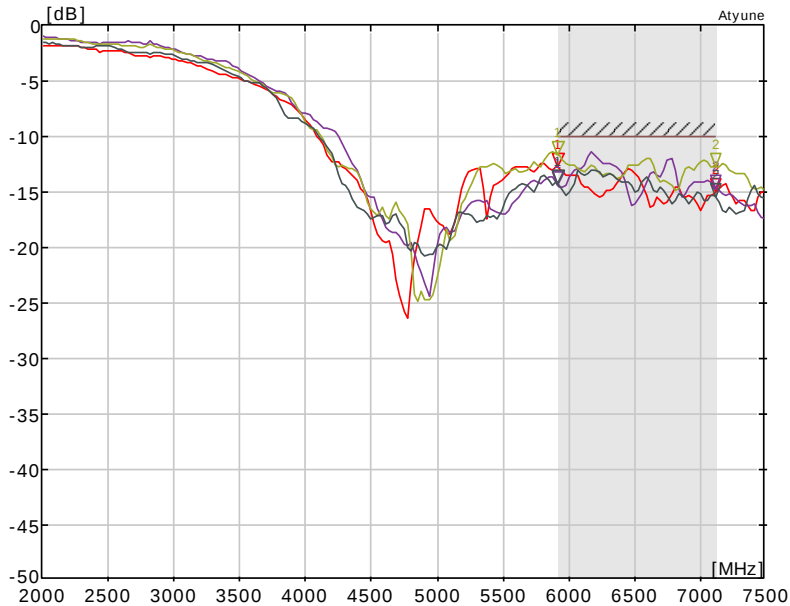
MARKERS:	MHz	dB
A2		
	1: 2400	-24.53
	2: 2490	-11.68
A3		
	1: 2400	-17.80
	2: 2490	-11.82
A4		
	1: 2400	-14.92
	2: 2490	-13.05
A5		
	1: 2400	-22.28
	2: 2490	-12.59
A6		
	1: 2400	-21.45
	2: 2490	-10.29

S-Parameter – Return Loss for 5G Antennas



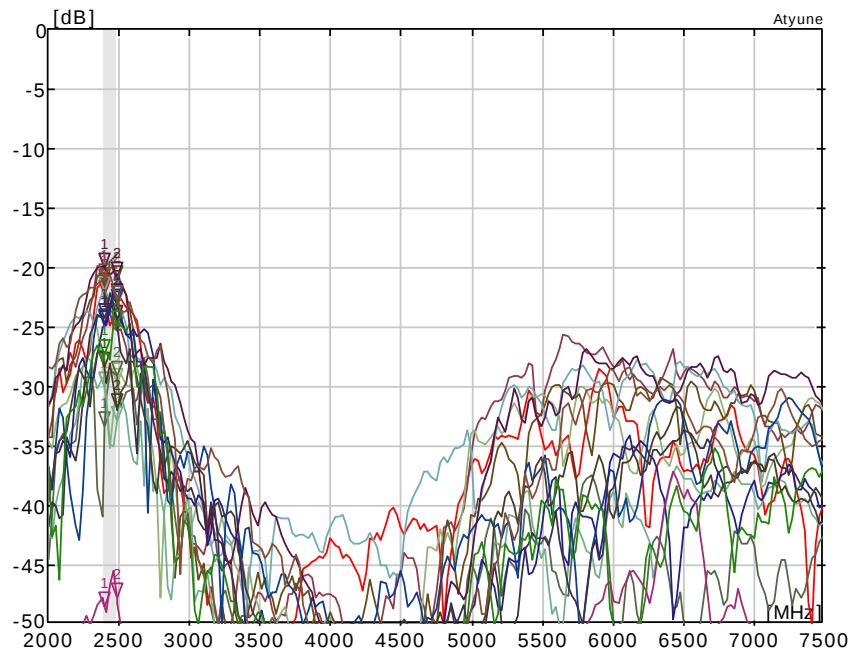
MARKERS:	MHz	dB
A10		
—	1: 5150	-12.71
	2: 5850	-12.00
A7		
—	1: 5150	-15.75
	2: 5850	-11.93
A8		
—	1: 5150	-21.43
	2: 5850	-12.40
A9		
—	1: 5150	-13.33
	2: 5850	-11.36

S-Parameter – Return Loss for 6G Antennas



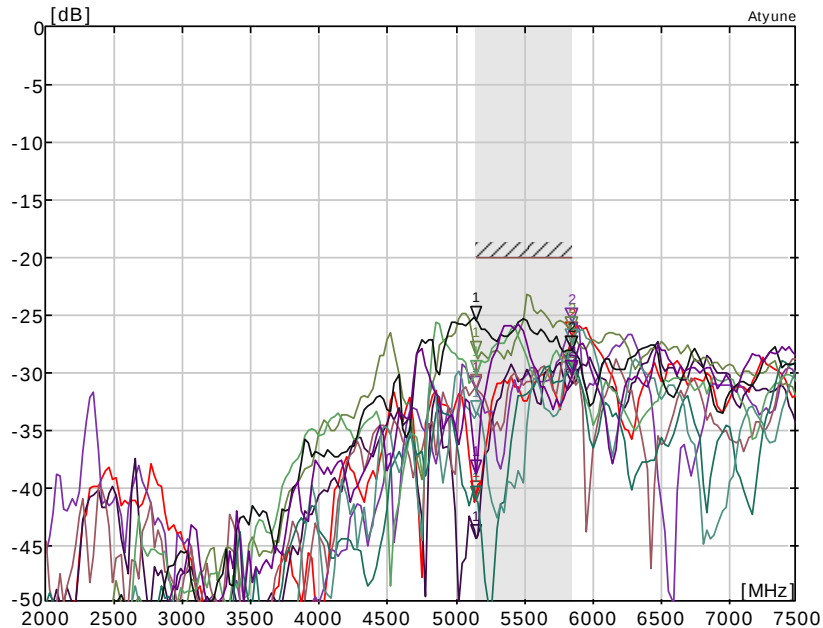
MARKERS:	MHz	dB
A11		
	1: 5925	-12.68
	2: 7125	-14.95
A12		
	1: 5925	-14.39
	2: 7125	-14.69
A13		
	1: 5925	-11.57
	2: 7125	-12.68
A14		
	1: 5925	-14.16
	2: 7125	-15.42

S-Parameter – Isolation between all 2G Antennas



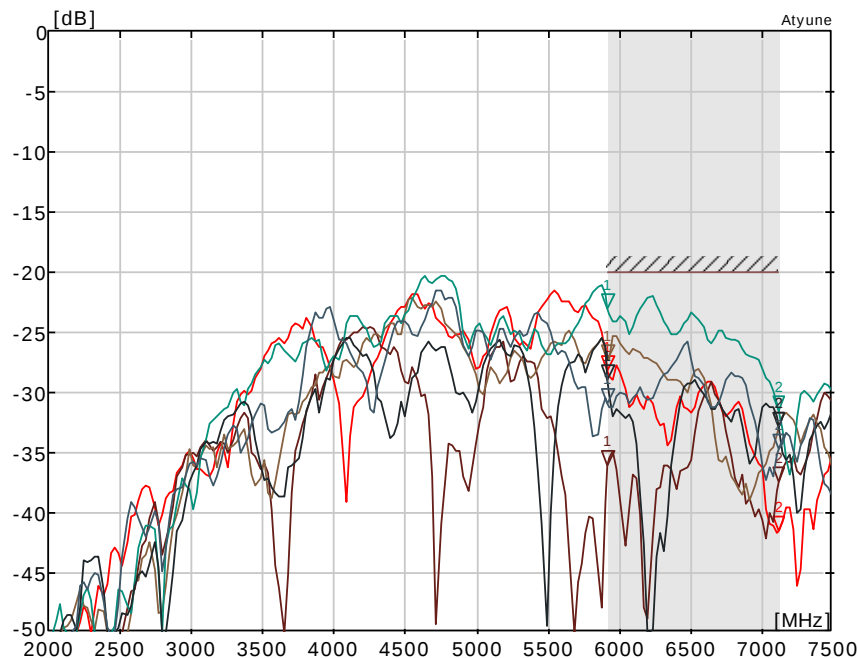
Antenna	Minimum Isolation (dB) Max value between the frequency band
2.4GHz-2.49GHz	-20.4

S-Parameter – Isolation between all 5G Antennas



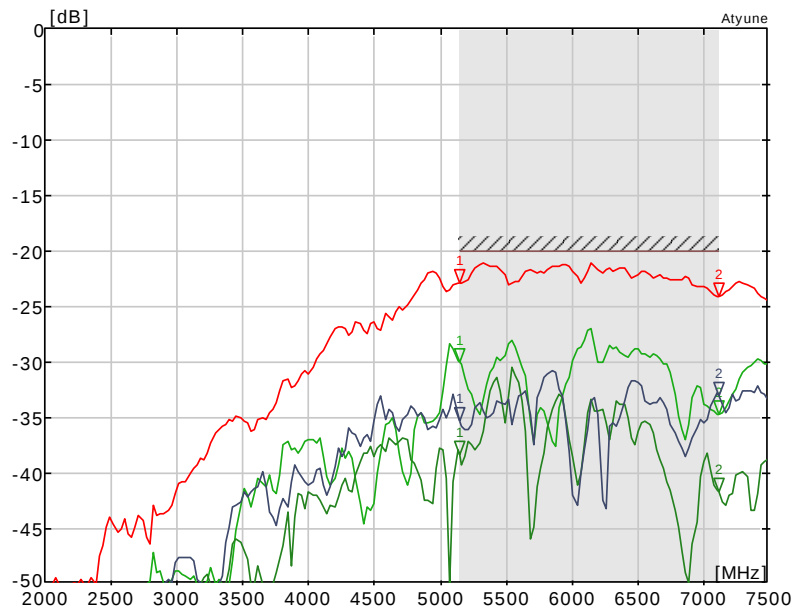
Antenna	Minimum Isolation (dB) Max value between the frequency band
5.15GHz-5.85GHz	-23.1

S-Parameter – Isolation between 6G Antennas



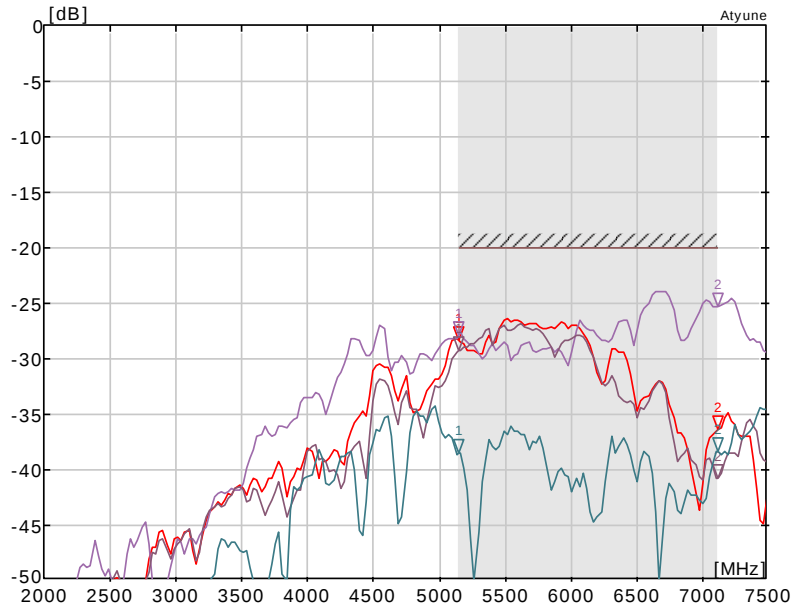
Antenna	Minimum Isolation (dB) Max value between the frequency band
5.925GHz-7.125GHz	-22.3

S-Parameter – Isolation between A7&6G Antennas



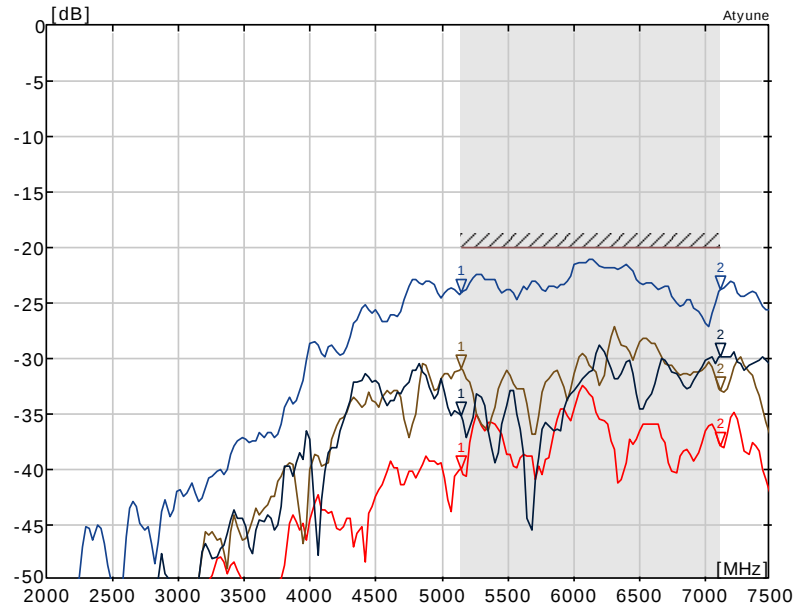
Antenna	Minimum Isolation (dB) Max value between the frequency band
5.925GHz-7.125GHz	-21.3

S-Parameter – Isolation between A8&6G Antennas



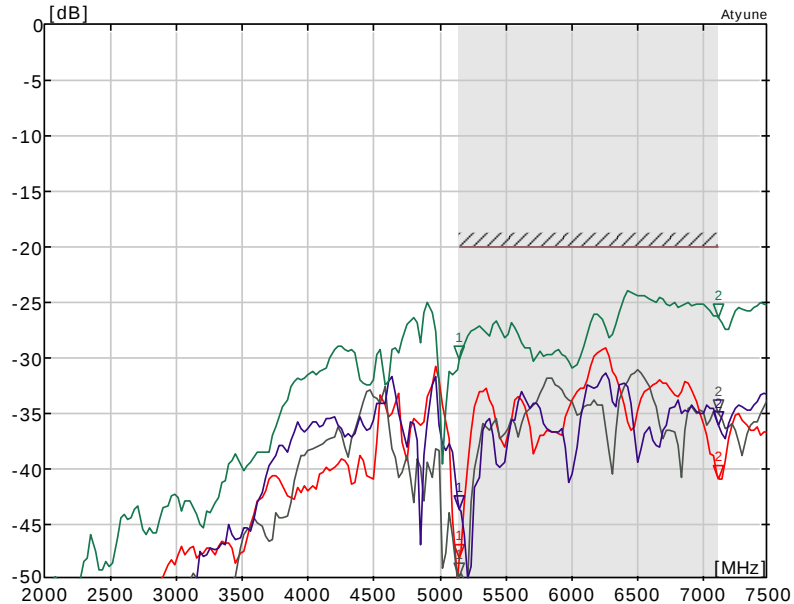
Antenna	Minimum Isolation (dB) Max value between the frequency band
5.925GHz-7.125GHz	-22.3

S-Parameter – Isolation between A9&6G Antennas



Antenna	Minimum Isolation (dB) Max value between the frequency band
5.925GHz-7.125GHz	-21.5

S-Parameter – Isolation between A10&6G Antennas



Antenna	Minimum Isolation (dB) Max value between the frequency band
5.925GHz-7.125GHz	-24.0

Radiated Measurements

Actual Equipment List and Calibration Information



Vendor	Model	Calibrated Date	Calibrated Until
MVG industries	SLv2	2021/12/13	2022/12/12
ROHDE&SCHWARZ	ZVB.8	2021/8/26	2022/8/25



- Test software:
Satimo Passive Measurement Version: 1.8.0
SatEnv Version: 3.0.3.0 build23

- location of the testing:
Airgain China office in Suzhou3
Test engineer: Terry Tao

Step 2: Connect DUT with Chamber



- Connect cable coming from DUT, designated as “Ant 1 ” to the chamber’s cable.
- Run sequence of radiated tests .
- Disconnect the chamber’s cable from Ant 1 .
- Repeat this process for all 9 RF ports of DUT.

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



Frequency (MHz)	Ant2_2G4 (%)	Ant3_2G4 (%)	Ant4_2G4 (%)	Ant5_2G4 (%)
2400	56.1	58.5	57.2	67.3
2410	56.4	58.4	58.9	67.4
2420	56.1	57.0	58.8	66.4
2430	56.1	56.2	59.7	65.5
2440	56.1	55.7	60.9	65.3
2450	55.5	55.2	61.1	64.4
2460	55.1	55.3	61.5	65.3
2470	54.7	55.5	61.4	66.7
2480	54.5	55.8	61.2	66.1
2490	53.9	55.5	61.0	65.0
Average	55.5	56.3	60.2	65.9

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



Frequency (MHz)	Ant7_5G (%)	Ant8_5G (%)	Ant9_5G (%)	Ant10_5G (%)
5150	59.9	54.6	57.8	64.2
5200	61.8	56.8	62.0	68.3
5300	61.9	56.3	63.5	71.6
5400	58.6	56.7	62.5	68.0
5500	60.1	56.6	63.8	71.1
5600	53.9	51.9	59.4	64.6
5700	52.6	50.9	56.4	66.2
5800	52.1	50.1	54.4	62.9
5850	49.4	48.2	52.8	60.7
Average	56.7	53.4	59.2	66.4

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



Frequency (MHz)	Ant11_6G (%)	Ant12_6G (%)	Ant13_6G (%)	Ant14_6G (%)
5925	64.6	69.3	64.1	65.6
6000	62.0	71.7	65.5	63.5
6100	59.1	67.1	62.8	60.8
6200	63.6	69.1	66.0	61.9
6300	63.1	69.1	64.7	62.3
6400	60.9	72.8	65.2	62.4
6500	57.9	70.0	64.0	59.3
6600	59.9	69.5	63.1	59.4
6700	60.5	65.6	65.5	61.3
6800	59.2	66.7	67.6	61.8
6900	57.3	67.8	66.6	59.2
7125	58.3	70.5	61.3	58.9
Average	60.5	69.1	64.7	61.4

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	3.0	4.0	3.7	4.4
2410	3.1	4.0	3.9	4.4
2420	3.1	4.0	4.0	4.3
2430	3.1	3.8	4.1	3.9
2440	2.7	3.8	4.0	5.0
2450	3.1	3.4	4.0	3.3
2460	3.0	3.4	4.1	3.3
2470	2.8	3.4	4.1	3.5
2480	2.7	3.3	4.0	3.5
2490	2.5	3.3	4.0	3.4

Antenna Peak Realized Gain – 5 GHz Wi-Fi Antennas



Frequency (MHz)	Ant7_5G (dBi)	Ant8_5G (dBi)	Ant9_5G (dBi)	Ant10_5G (dBi)
5150	3.6	3.5	3.1	4.0
5200	3.6	4.1	3.4	4.8
5300	3.6	4.1	4.6	5.1
5400	3.4	3.4	5.2	4.1
5500	3.7	4.8	5.4	5.4
5600	3.5	3.9	5.4	4.7
5700	3.5	4.1	4.3	4.7
5800	3.1	4.0	3.8	4.2
5850	3.4	3.9	4.5	4.2

Antenna Peak Realized Gain – 6 GHz Wi-Fi Antennas



Frequency (MHz)	Ant11_6G (dBi)	Ant12_6G (dBi)	Ant13_6G (dBi)	Ant14_6G (dBi)
5925	4.9	5.4	5.6	5.7
6000	4.9	6.0	6.1	5.8
6100	4.5	6.0	5.0	5.7
6200	4.9	6.3	5.2	5.3
6300	4.9	6.8	5.1	5.3
6400	4.4	6.8	5.5	5.1
6500	4.5	6.6	6.6	6.9
6600	4.3	6.8	5.9	6.7
6700	3.9	6.2	6.3	6.4
6800	3.9	6.5	7.3	6.5
6900	4.3	5.8	7.3	6.2
7125	3.8	4.6	7.3	5.0

Antenna Peak Gain & Efficiency– Additional Antennas



Ant1_2G4		
Frequency (MHz)	Peak Gain (dBi)	Efficiency (%)
2400	3.8	64.0
2410	3.8	64.9
2420	3.7	64.8
2430	3.6	64.3
2440	3.9	64.0
2450	3.1	63.5
2460	3.3	64.7
2470	3.5	65.8
2480	3.3	65.5
2490	3.1	64.5
Average	-	64.6

Ant1_5G		
Frequency (MHz)	Peak Gain (dBi)	Efficiency (%)
5150	5.0	72.1
5200	5.7	72.1
5300	5.8	73.6
5400	4.8	68.5
5500	5.1	71.6
5600	5.3	66.7
5700	4.7	64.8
5800	4.7	62.9
5850	5.4	62.0
Average	-	68.3

Ant6_BT		
Frequency (MHz)	Peak Gain (dBi)	Efficiency (%)
2400	4.0	67.0
2410	4.0	67.6
2420	3.9	66.4
2430	4.1	64.9
2440	4.9	64.9
2450	4.2	64.4
2460	3.9	65.0
2470	3.8	65.2
2480	3.5	63.6
2490	3.5	61.9
Average	-	65.1

Radiation Patterns

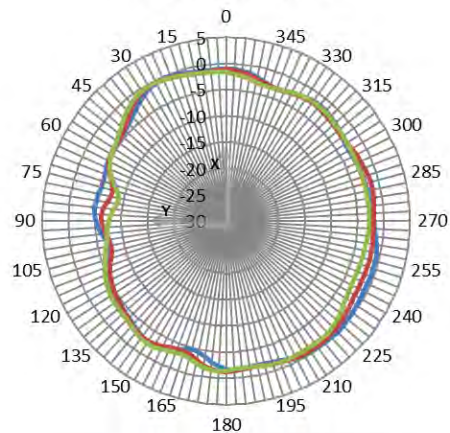


Orientation of EAI2308P

Total Gain Patterns: Ant2_2G4



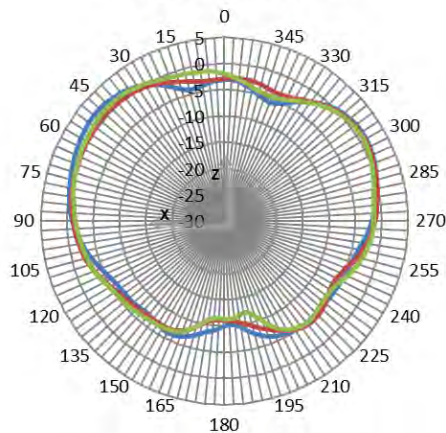
Ant2_2G4 Azimuth XY



— 2400MHz: Max=-0.02 Avg=-2.30
— 2440MHz: Max=-0.32 Avg=-2.45
— 2480MHz: Max=-0.29 Avg=-2.65

Azimuth (XY)

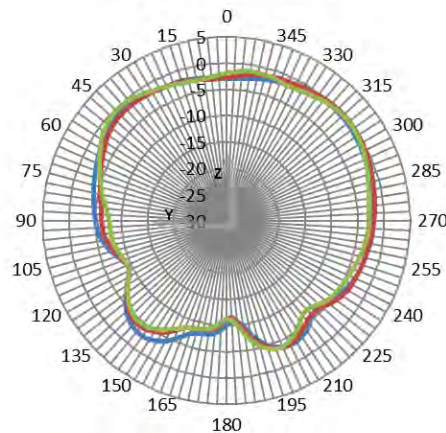
Ant2_2G4 Elevation XZ



— 2400MHz: Max=1.98 Avg=-2.22
— 2440MHz: Max=1.01 Avg=-2.41
— 2480MHz: Max=1.07 Avg=-2.32

Side to Side (XZ)

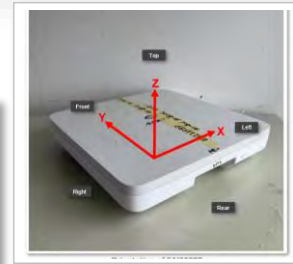
Ant2_2G4 Elevation YZ



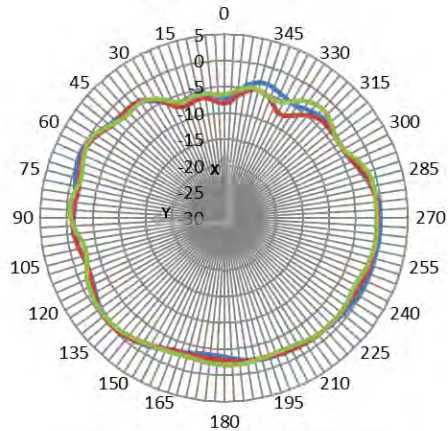
— 2400MHz: Max=-0.38 Avg=-3.10
— 2440MHz: Max=0.10 Avg=-3.15
— 2480MHz: Max=-0.05 Avg=-3.36

Front to Back (YZ)

Total Gain Patterns: Ant3_2G4



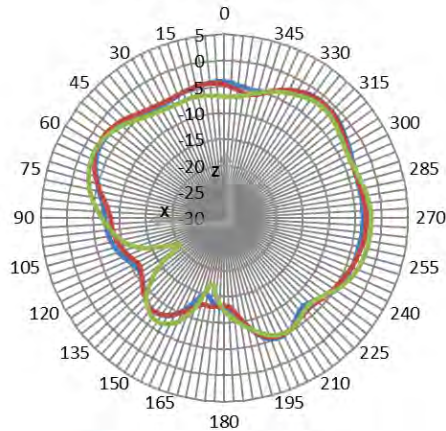
Ant3_2G4 Azimuth XY



— 2400MHz: Max=0.12 Avg=-2.10
— 2440MHz: Max=-0.27 Avg=-2.34
— 2480MHz: Max=-0.29 Avg=-2.18

Azimuth (XY)

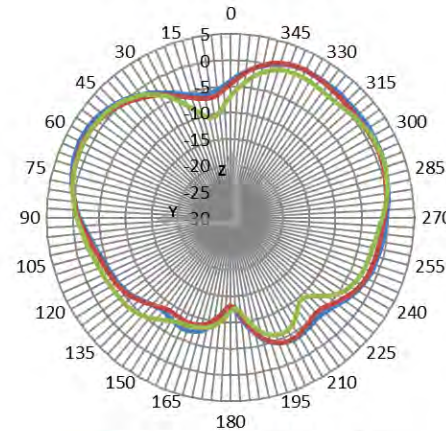
Ant3_2G4 Elevation XZ



— 2400MHz: Max=-1.01 Avg=-4.94
— 2440MHz: Max=-1.15 Avg=-4.92
— 2480MHz: Max=-1.83 Avg=-5.00

Side to Side (XZ)

Ant3_2G4 Elevation YZ



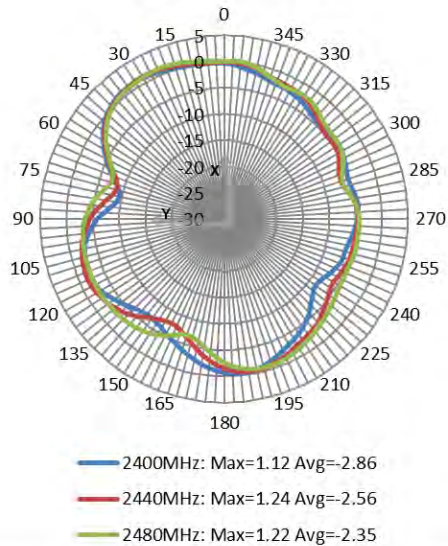
— 2400MHz: Max=2.20 Avg=-1.42
— 2440MHz: Max=1.56 Avg=-1.79
— 2480MHz: Max=1.42 Avg=-2.14

Front to Back (YZ)

Total Gain Patterns: Ant4_2G4

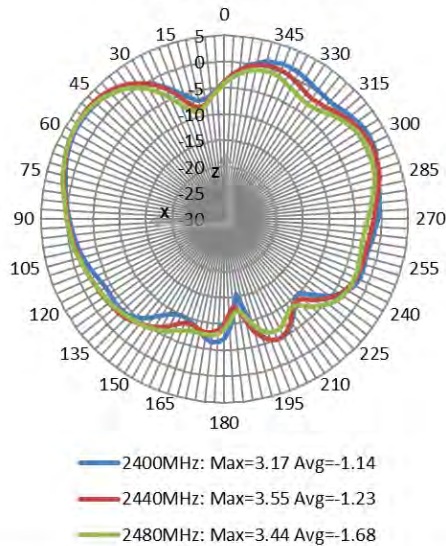


Ant4_2G4 Azimuth XY



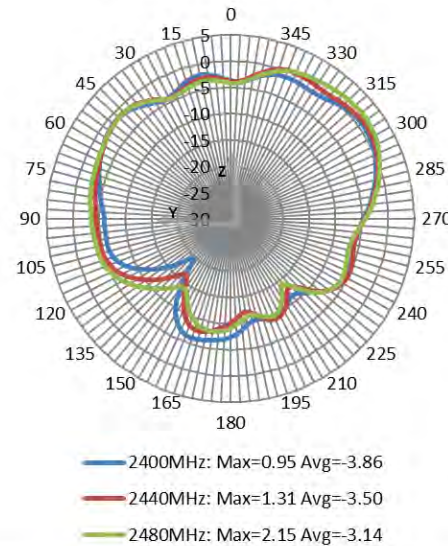
Azimuth (XY)

Ant4_2G4 Elevation XZ



Side to Side (XZ)

Ant4_2G4 Elevation YZ



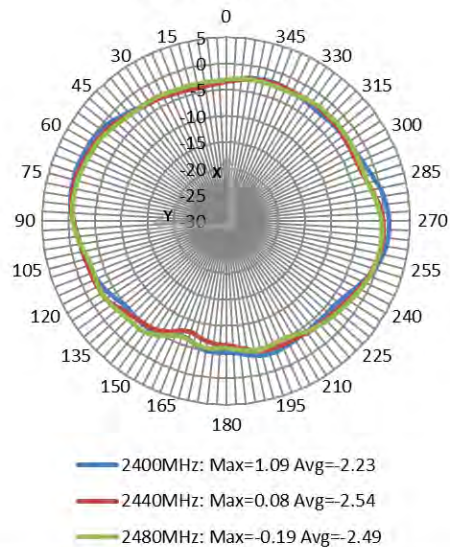
Front to Back (YZ)



Total Gain Patterns: Ant5_2G4

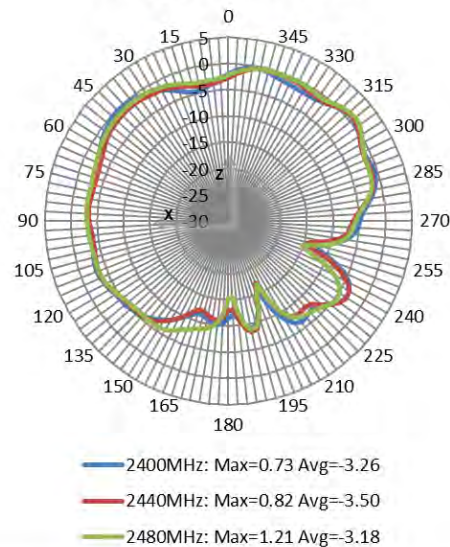


Ant5_2G4 Azimuth XY



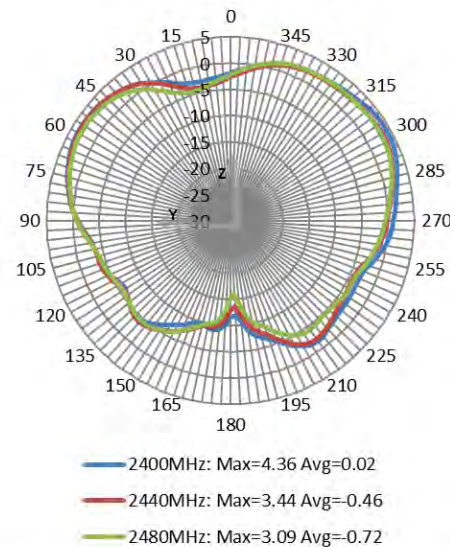
Azimuth (XY)

Ant5_2G4 Elevation XZ



Side to Side (XZ)

Ant5_2G4 Elevation YZ



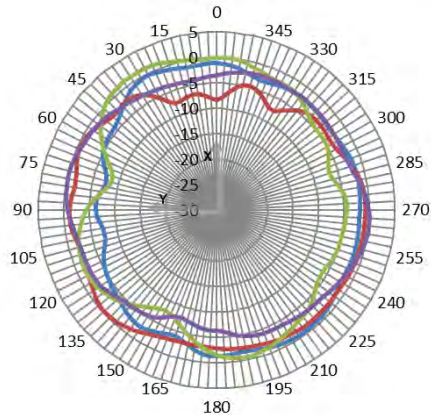
Front to Back (YZ)



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



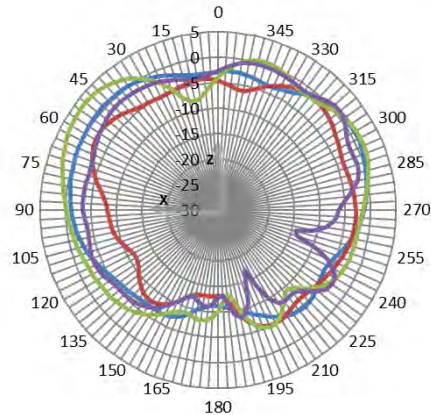
Azimuth XY 2440MHz



— Ant2_2G4: Max=-0.32 Avg=-2.45
— Ant3_2G4: Max=-0.27 Avg=-2.34
— Ant4_2G4: Max=1.24 Avg=-2.56
— Ant5_2G4: Max=0.08 Avg=-2.54

Azimuth (XY)

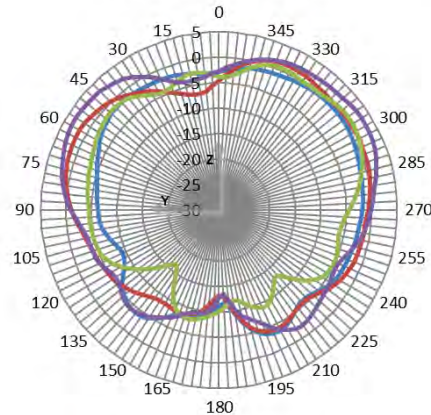
Elevation XZ 2440MHz



— Ant2_2G4: Max=1.01 Avg=-2.41
— Ant3_2G4: Max=-1.15 Avg=-4.92
— Ant4_2G4: Max=3.55 Avg=-1.23
— Ant5_2G4: Max=0.82 Avg=-3.50

Side to Side (XZ)

Elevation YZ 2440MHz



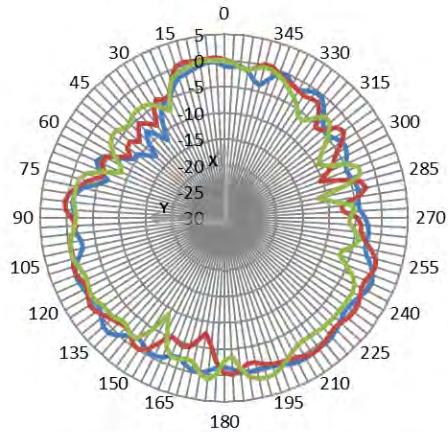
— Ant2_2G4: Max=0.10 Avg=-3.15
— Ant3_2G4: Max=1.56 Avg=-1.79
— Ant4_2G4: Max=1.31 Avg=-3.50
— Ant5_2G4: Max=3.44 Avg=-0.46

Front to Back (YZ)

Total Gain Patterns: Ant7_5G

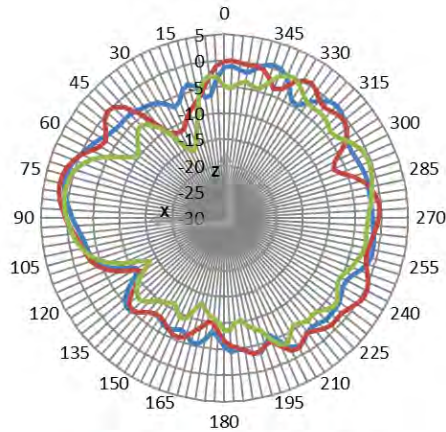


Ant7_5G Azimuth XY



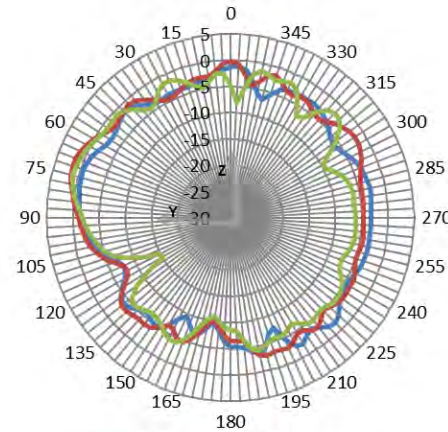
Azimuth (XY)

Ant7_5G Elevation XZ



Side to Side (XZ)

Ant7_5G Elevation YZ



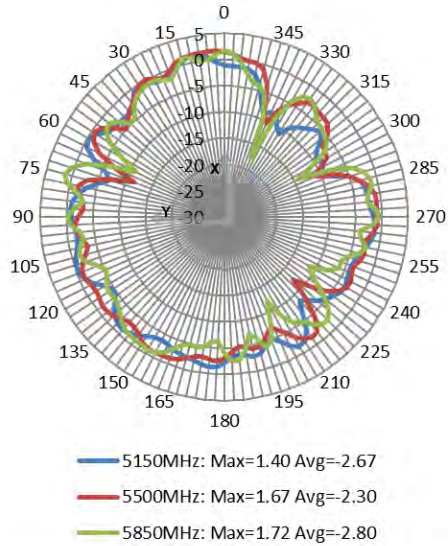
Front to Back (YZ)



Total Gain Patterns: Ant8_5G

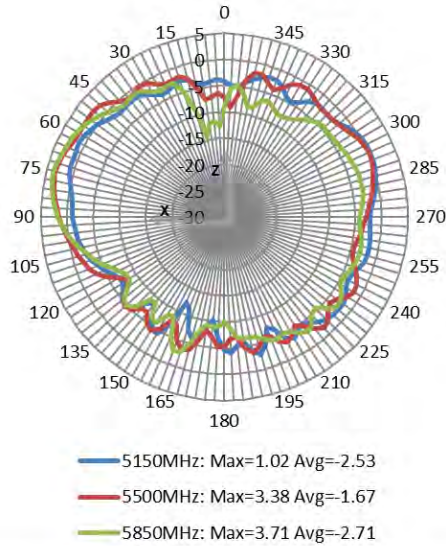


Ant8_5G Azimuth XY



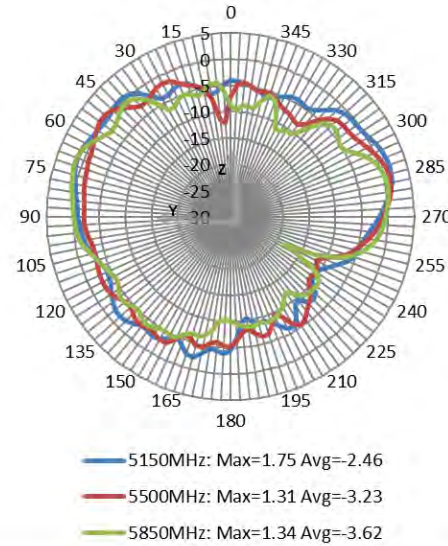
Azimuth (XY)

Ant8_5G Elevation XZ



Side to Side (XZ)

Ant8_5G Elevation YZ



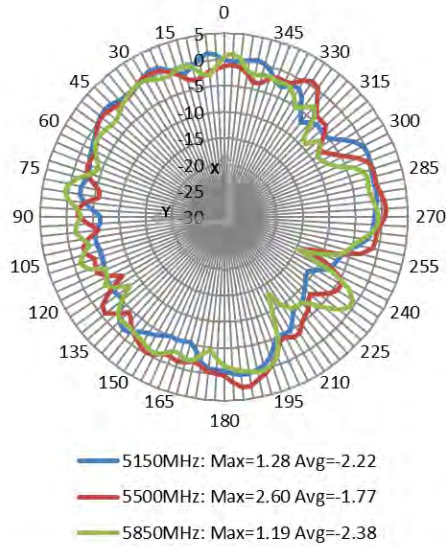
Front to Back (YZ)



Total Gain Patterns: Ant9_5G

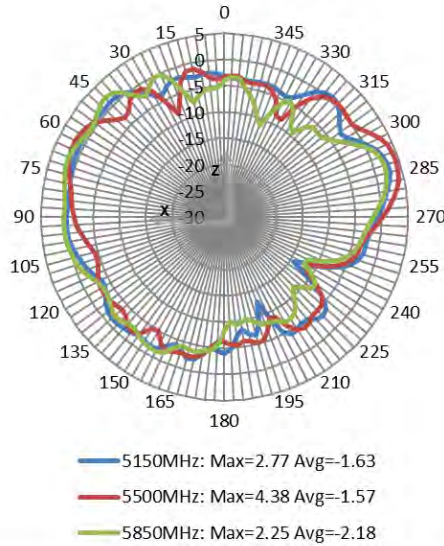


Ant9_5G Azimuth XY



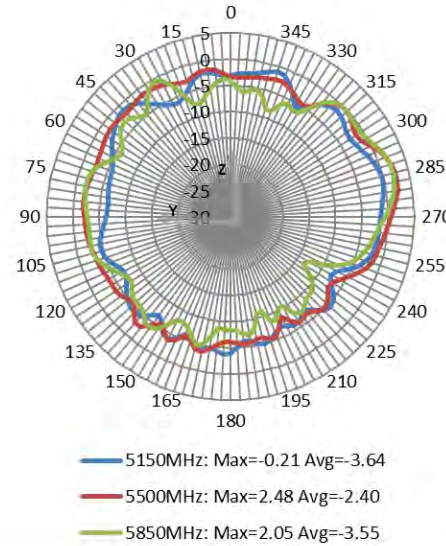
Azimuth (XY)

Ant9_5G Elevation XZ



Side to Side (XZ)

Ant9_5G Elevation YZ



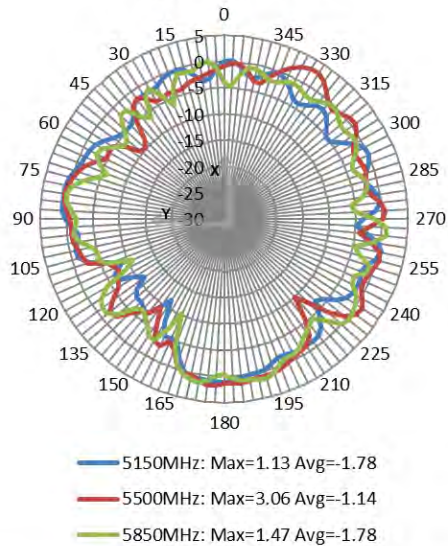
Front to Back (YZ)



Total Gain Patterns: Ant10_5G

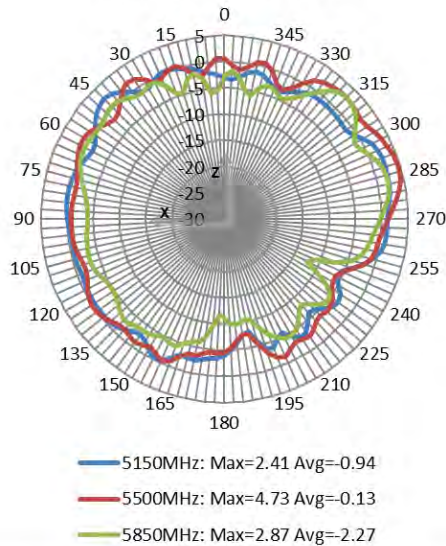


Ant10_5G Azimuth XY



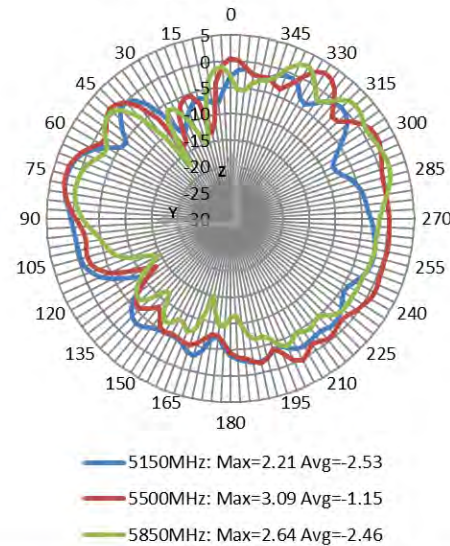
Azimuth (XY)

Ant10_5G Elevation XZ



Side to Side (XZ)

Ant10_5G Elevation YZ



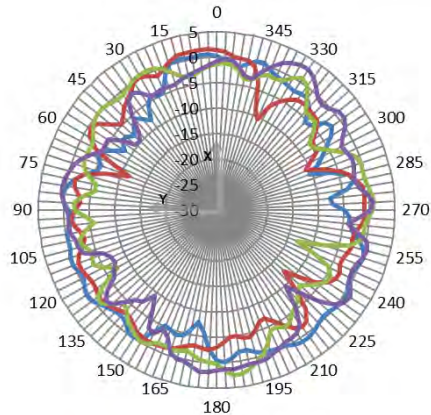
Front to Back (YZ)



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



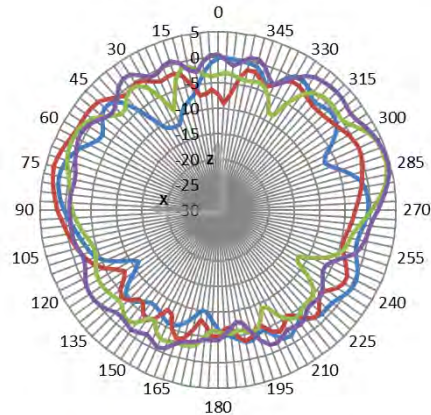
Azimuth XY 5500MHz



— Ant7_5G: Max=0.81 Avg=-1.66
— Ant8_5G: Max=1.67 Avg=-2.30
— Ant9_5G: Max=2.60 Avg=-1.77
— Ant10_5G: Max=3.06 Avg=-1.14

Azimuth (XY)

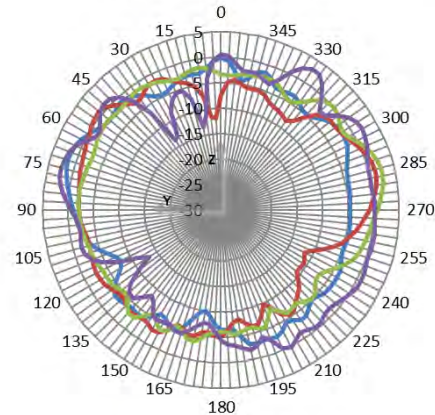
Elevation XZ 5500MHz



— Ant7_5G: Max=2.07 Avg=-2.25
— Ant8_5G: Max=3.38 Avg=-1.67
— Ant9_5G: Max=4.38 Avg=-1.57
— Ant10_5G: Max=4.73 Avg=-0.13

Side to Side (XZ)

Elevation YZ 5500MHz



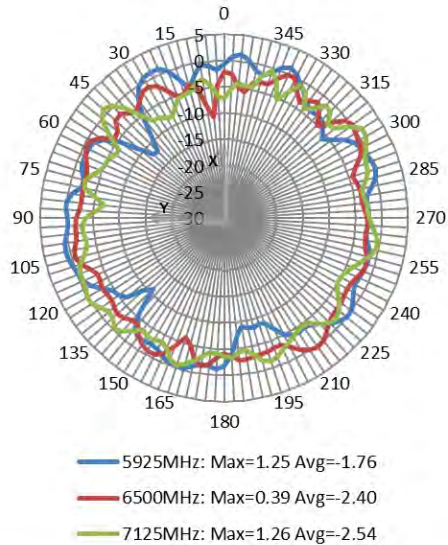
— Ant7_5G: Max=1.64 Avg=-2.96
— Ant8_5G: Max=1.31 Avg=-3.23
— Ant9_5G: Max=2.48 Avg=-2.40
— Ant10_5G: Max=3.09 Avg=-1.15

Front to Back (YZ)

Total Gain Patterns: Ant11_6G

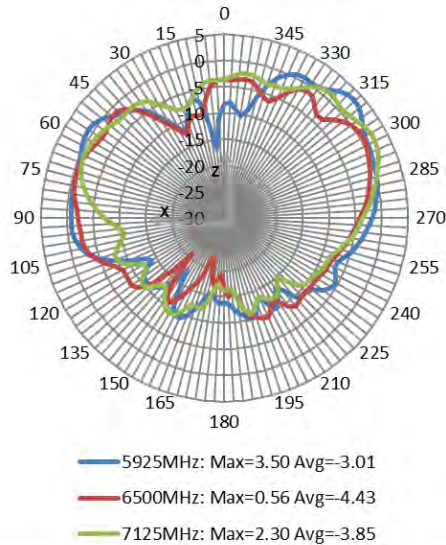


Ant11_6G Azimuth XY



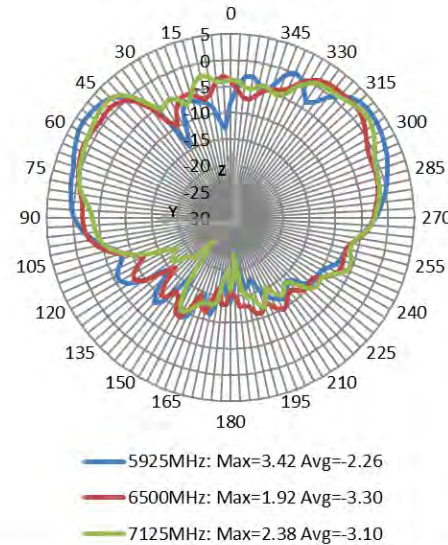
Azimuth (XY)

Ant11_6G Elevation XZ



Side to Side (XZ)

Ant11_6G Elevation YZ



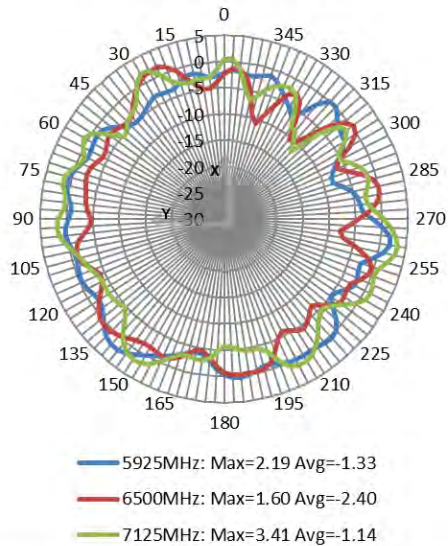
Front to Back (YZ)



Total Gain Patterns: Ant12_6G

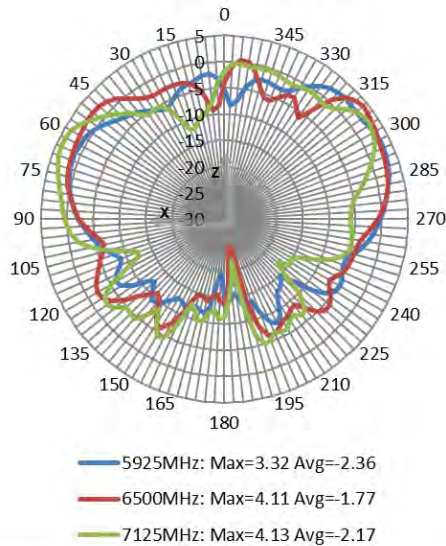


Ant12_6G Azimuth XY



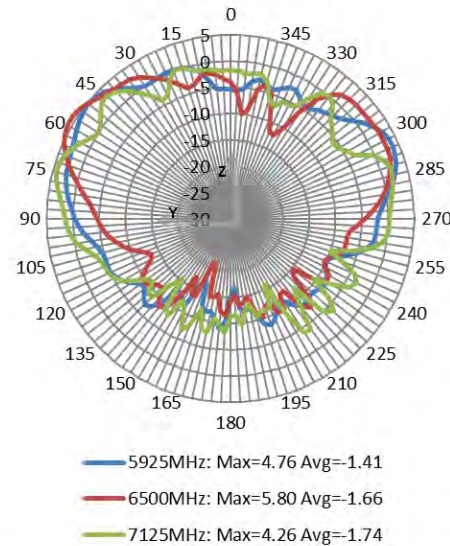
Azimuth (XY)

Ant12_6G Elevation XZ



Side to Side (XZ)

Ant12_6G Elevation YZ



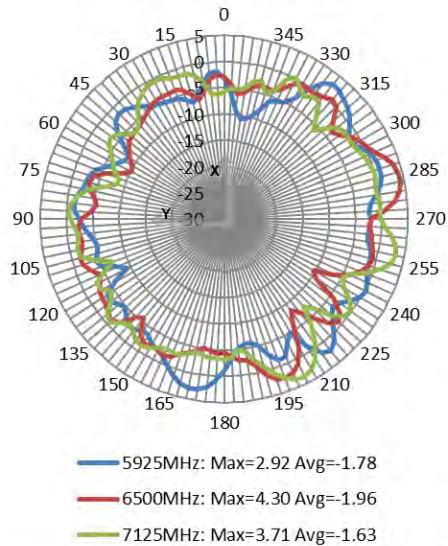
Front to Back (YZ)



Total Gain Patterns: Ant13_6G

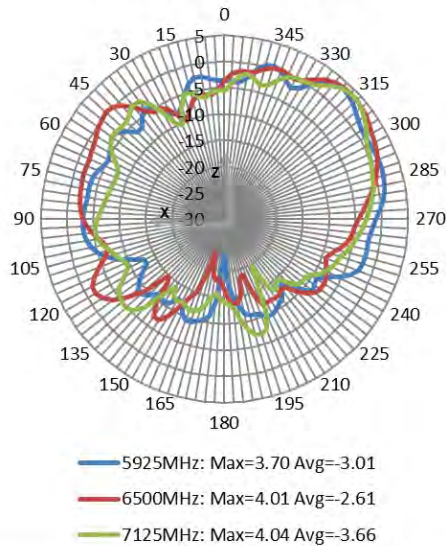


Ant13_6G Azimuth XY



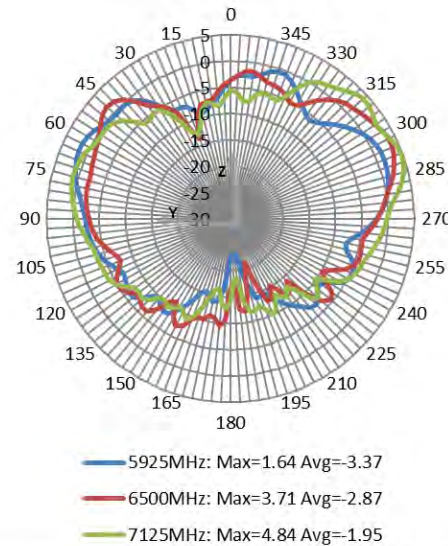
Azimuth (XY)

Ant13_6G Elevation XZ



Side to Side (XZ)

Ant13_6G Elevation YZ



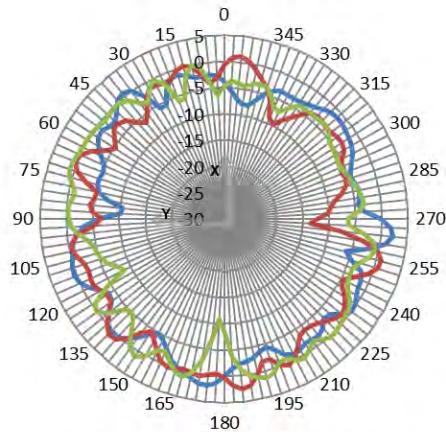
Front to Back (YZ)



Total Gain Patterns: Ant14_6G

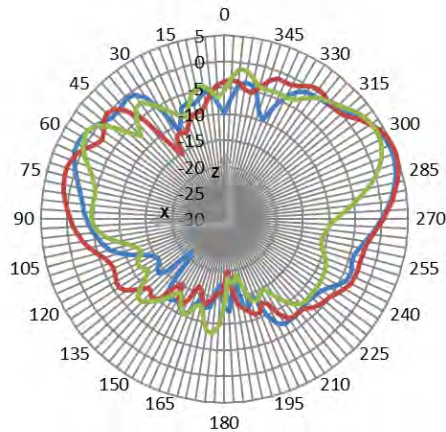


Ant14_6G Azimuth XY



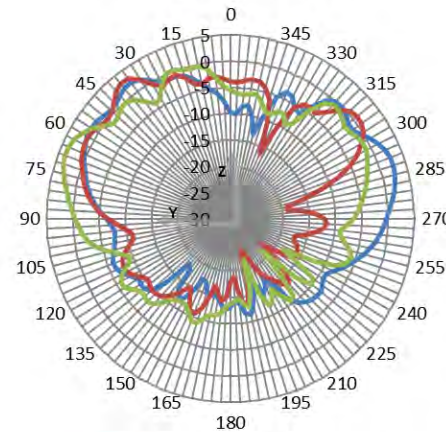
Azimuth (XY)

Ant14_6G Elevation XZ



Side to Side (XZ)

Ant14_6G Elevation YZ



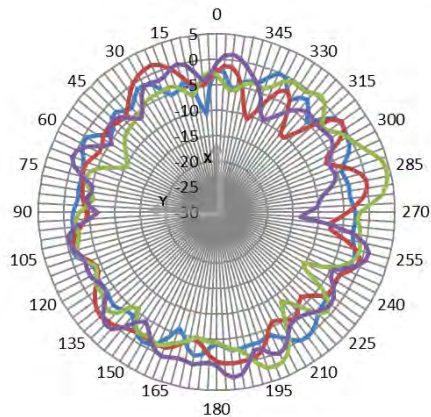
Front to Back (YZ)



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



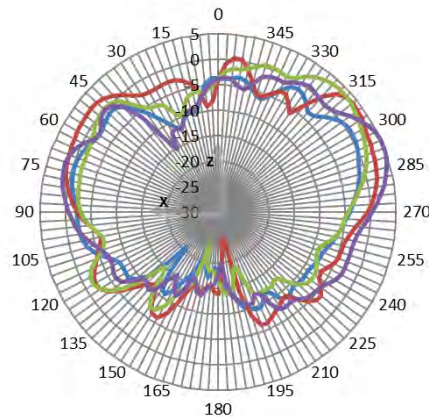
Azimuth XY 6500MHz



— Ant11_6G: Max=0.39 Avg=-2.40
— Ant12_6G: Max=1.60 Avg=-2.40
— Ant13_6G: Max=4.30 Avg=-1.96
— Ant14_6G: Max=2.58 Avg=-2.03

Azimuth (XY)

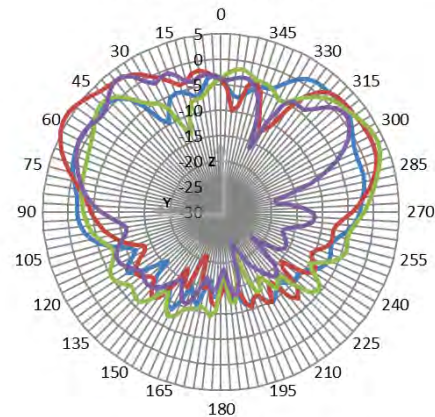
Elevation XZ 6500MHz



— Ant11_6G: Max=0.56 Avg=-4.43
— Ant12_6G: Max=4.11 Avg=-1.77
— Ant13_6G: Max=4.01 Avg=-2.61
— Ant14_6G: Max=5.01 Avg=-1.98

Side to Side (XZ)

Elevation YZ 6500MHz



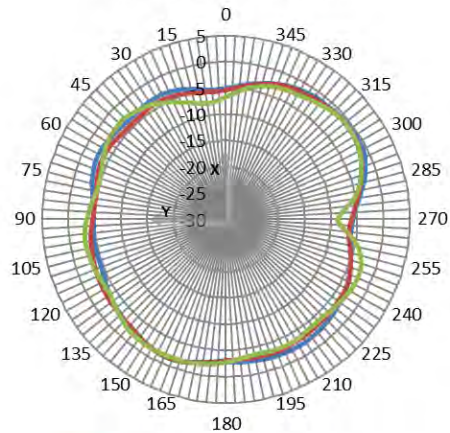
— Ant11_6G: Max=1.92 Avg=-3.30
— Ant12_6G: Max=5.80 Avg=-1.66
— Ant13_6G: Max=3.71 Avg=-2.87
— Ant14_6G: Max=3.21 Avg=-4.35

Front to Back (YZ)

Total Gain Patterns: Ant1_2G4



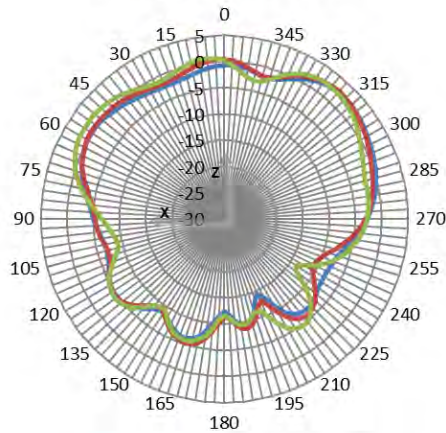
Ant1_2G4 Azimuth XY



— 2400MHz: Max=-0.52 Avg=-2.94
— 2440MHz: Max=-0.84 Avg=-3.28
— 2480MHz: Max=-0.79 Avg=-3.26

Azimuth (XY)

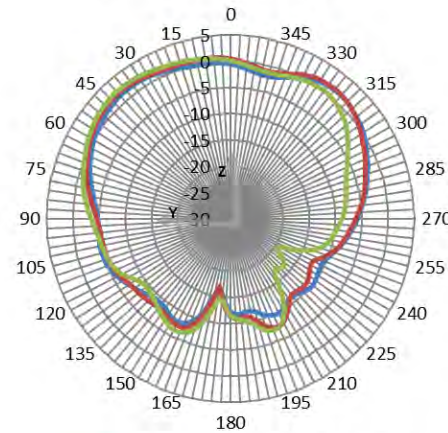
Ant1_2G4 Elevation XZ



— 2400MHz: Max=2.55 Avg=-2.50
— 2440MHz: Max=2.76 Avg=-2.29
— 2480MHz: Max=2.37 Avg=-2.17

Side to Side (XZ)

Ant1_2G4 Elevation YZ



— 2400MHz: Max=1.56 Avg=-2.75
— 2440MHz: Max=1.97 Avg=-2.33
— 2480MHz: Max=2.48 Avg=-2.67

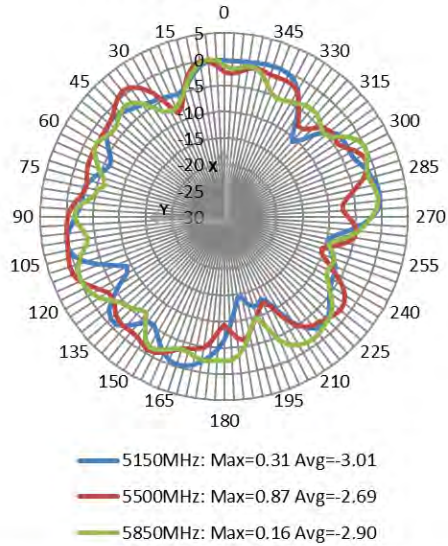
Front to Back (YZ)



Total Gain Patterns: Ant1_5G

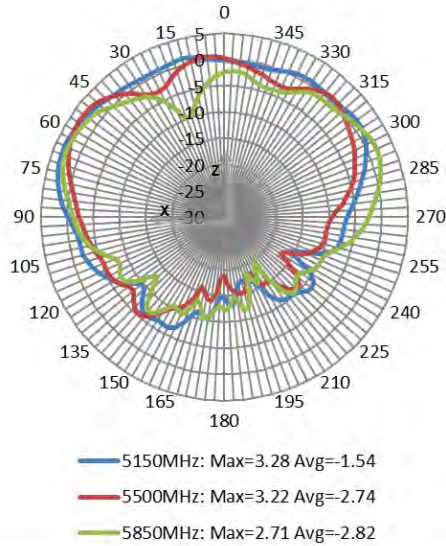


Ant1_5G Azimuth XY



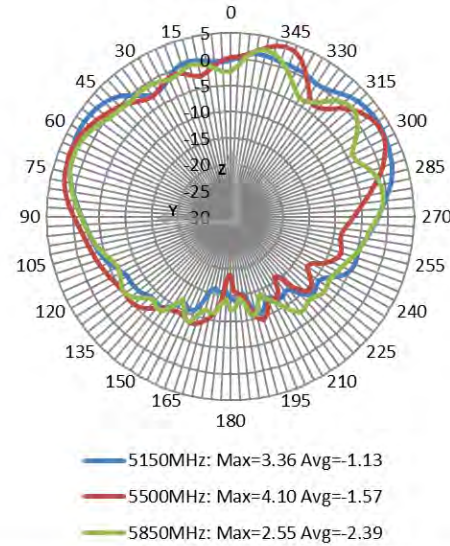
Azimuth (XY)

Ant1_5G Elevation XZ



Side to Side (XZ)

Ant1_5G Elevation YZ



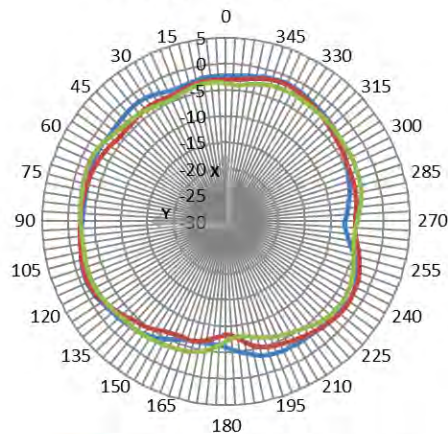
Front to Back (YZ)



Total Gain Patterns: Ant6_BT



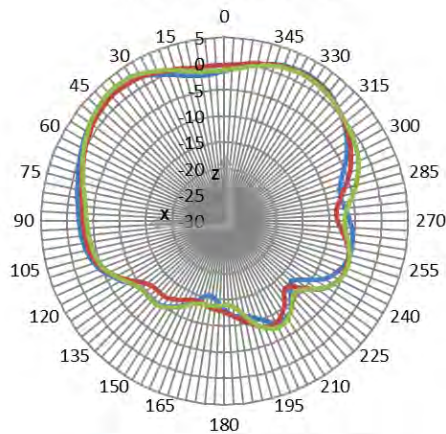
Ant6_BT Azimuth XY



— 2400MHz: Max=-1.11 Avg=-2.98
— 2440MHz: Max=-1.18 Avg=-3.41
— 2480MHz: Max=-1.67 Avg=-3.48

Azimuth (XY)

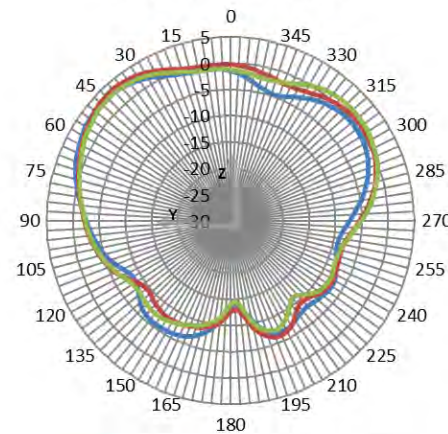
Ant6_BT Elevation XZ



— 2400MHz: Max=2.43 Avg=-2.36
— 2440MHz: Max=2.09 Avg=-2.41
— 2480MHz: Max=2.97 Avg=-2.24

Side to Side (XZ)

Ant6_BT Elevation YZ



— 2400MHz: Max=3.20 Avg=-2.42
— 2440MHz: Max=3.59 Avg=-1.82
— 2480MHz: Max=2.94 Avg=-1.99

Front to Back (YZ)



- Return Loss:
Below -10dB for all antennas
- Isolation:
Below -20dB between all antennas
- Efficiency :
A8's cable length is too long, so it's efficiency do not get 50%