



VVDN_Arista_C400_Antenna Measurement_A0-03

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18-12-2024

Required Antenna Specifications

Antenna & RF Cable	<ul style="list-style-type: none">○ Frequency<ul style="list-style-type: none">▪ 2400 MHz – 2483 MHz▪ 4900 MHz – 5850 MHz▪ 5925 MHz – 7125 MHz○ Peak Gain<ul style="list-style-type: none">▪ ≥ 4 dBi@ 2.4~2.4835 GHz▪ ≥ 5 dBi@ 4.9~5.85 GHz▪ ≥ 5 dBi@ 5.925~7.125 GHz○ Return loss<ul style="list-style-type: none">▪ ≥ 10 dB○ Efficiency<ul style="list-style-type: none">▪ Single band efficiency of $\geq 75\%$ at all frequencies for internal antennas○ Voltage Standing Wave Ratio (V.S.W.R)<ul style="list-style-type: none">▪ ≤ 2.0 @ 2.4~2.4835 GHz▪ ≤ 2.0 @ 4.9~5.85 GHz▪ ≤ 2.0 @ 5.925~7.125 GHz○ Polarisation<ul style="list-style-type: none">▪ Linear● RF Cable Insertion loss between module and antenna<ul style="list-style-type: none">○ ≤ 0.5 dB @ 2.4~2.4835 GHz○ ≤ 1 dB @ 4.9~5.85 GHz○ ≤ 1 dB @ 5.925~7.125 GHz
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Objectives

- Antenna customization for 2.4, 5 and 6 GHz AP (2x2 - 5GHz, 2x2 - 6GHz and 2X2 - 2.4 GHz)
- Measurement with the antenna system and device (With updated 6GHz antenna).

Antenna Measurement Setup Details

Anechoic Chamber (700MHz – 7.5GHz)

General Specification	
Frequency Range	700MHz-7.5GHz
Attenuation	< 60dB
Tx and Rx antenna separation	12 meters

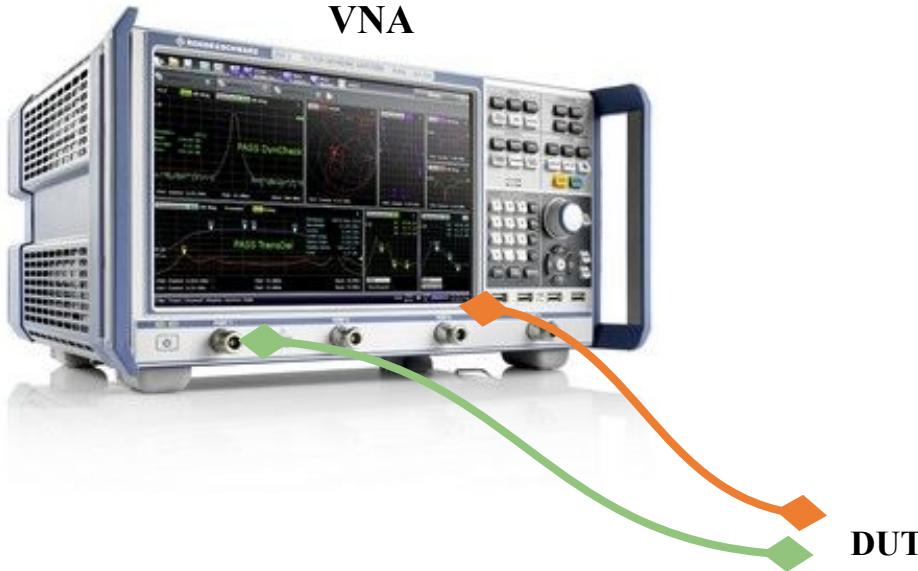
Motor Specification	
Position Accuracy	0.5 degree
	Azimuth (AZ) = 360° rotation
	Elevation (EL) = ±90°
Positioner Movement	Polarization Axis = 360°

Shielding Effectiveness	
Frequency Range	700MHz-7.5GHz
Shielding Effectiveness	>80dB
Test Procedure Standard	STD-IEEE-299/ MIL STD 285
Size available for shielding shall	15.5m x 4m x 4m

VNA Specification	
Model	ZNB40
Manufacturer	Rohde & Schwarz
Operating Frequency Range	100 kHz to 40 GHz
No of Port	4

Other Specification	
Quiet Zone Size	50-80cm x 50-80cm x 50-80cm @Throughout Band
Test Zone Quietness* (in dB)	>-38 @700MHz >-44 @2GHz >-48 @7.5GHz

Test Equipment

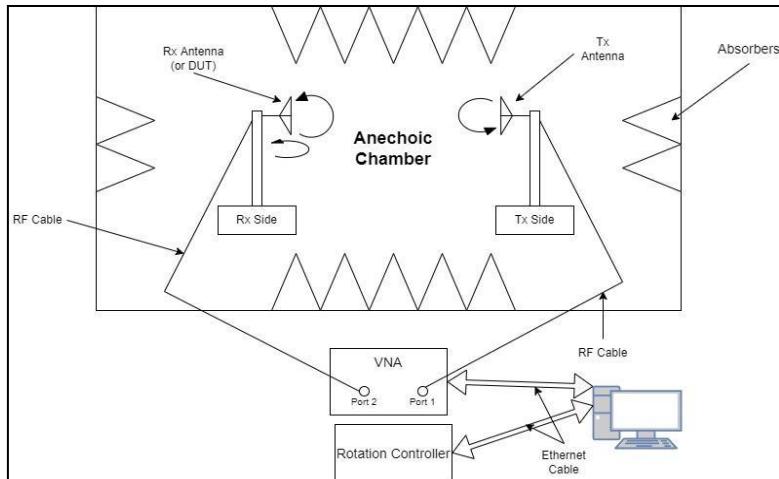


**Test Setup for Measurement of Return Loss,
VSWR and Isolation of Antenna**

Manufacturer	Rohde & Schwarz
Model No	ZNB40
Operating frequency	100 KHz to 40 GHz
Certificate No.	20-921315-C

Details of the Vector Network Analyzer (VNA)

Gain and Radiation Pattern Measurement



The block diagram of the test setup

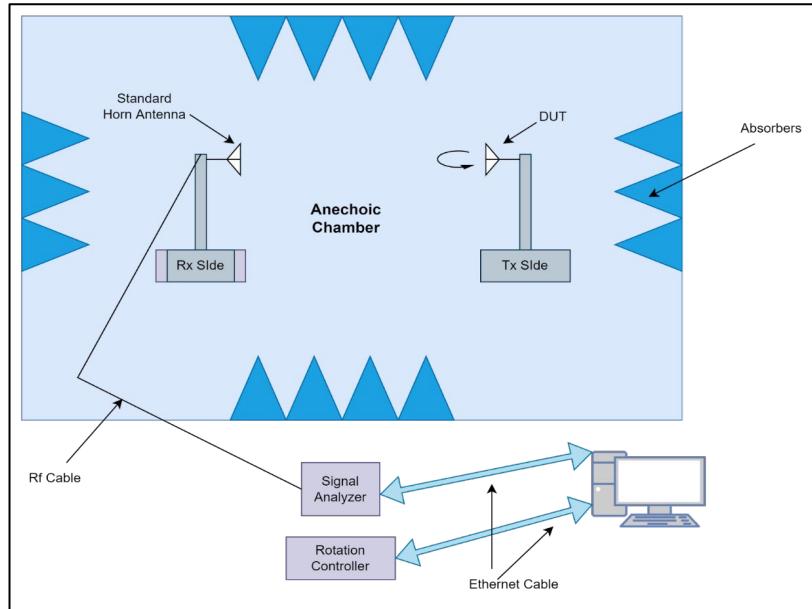
Manufacturer	Rohde & Schwarz
Model No	ZNB40
Operating frequency	100 KHz to 40 GHz
Certificate No.	20-921315-C

Details of the Vector Network Analyzer (VNA)

Manufacturer	JV Micronics
Model No	DAC 3002

Details of the rotation controller

Anechoic Chamber (700MHz – 7.5GHz)

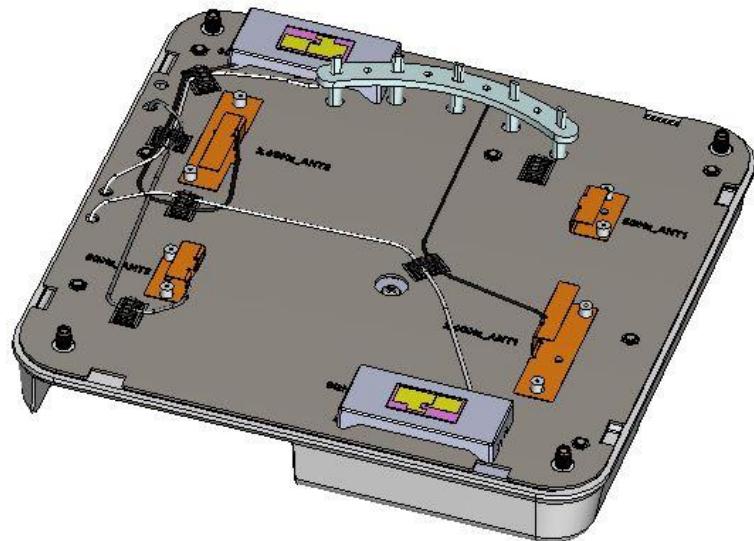
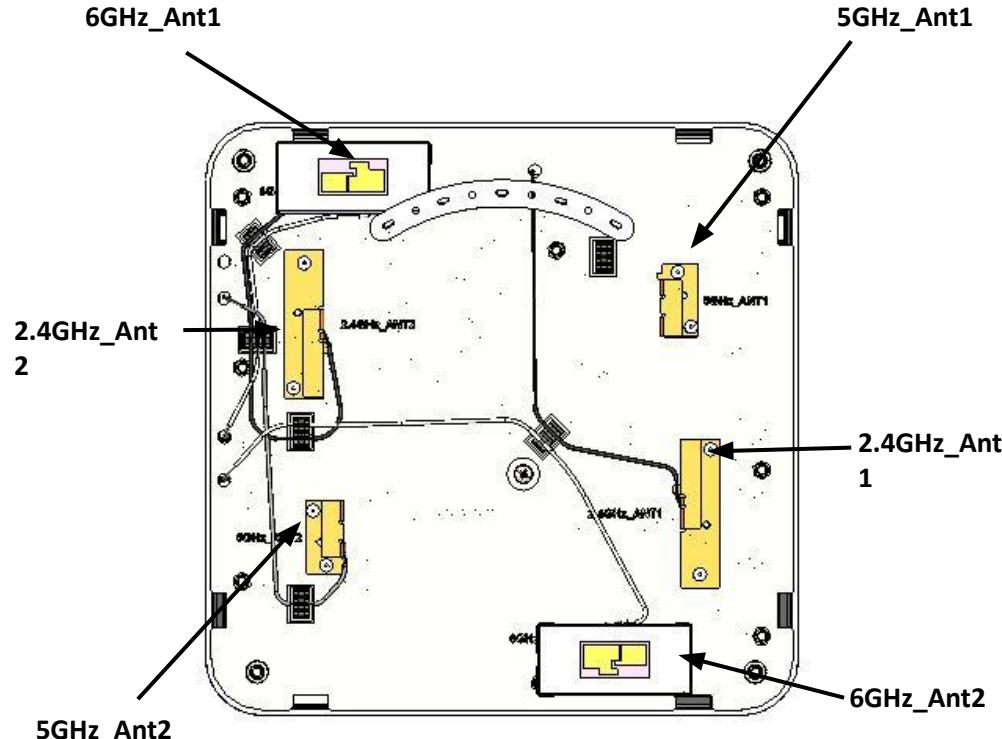


Block Diagram



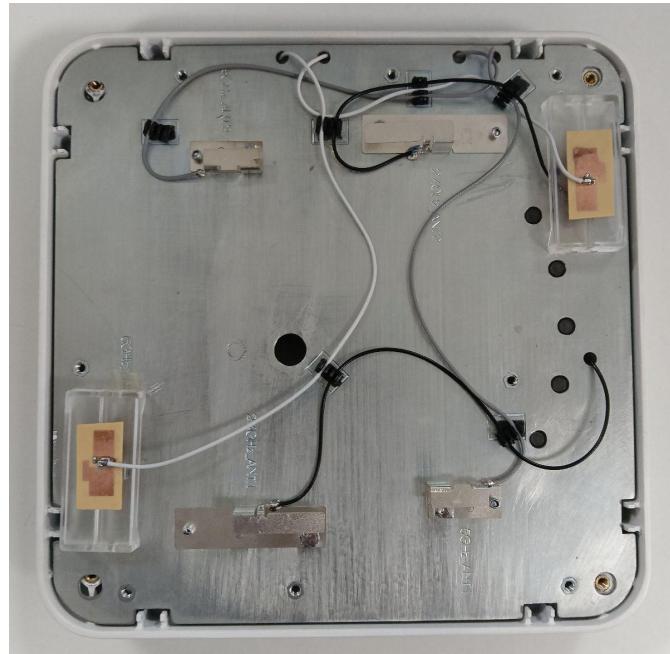
Chamber Inside View

Antenna Placement



Isometric & Top Views with Antenna Numberings

Antenna Placement

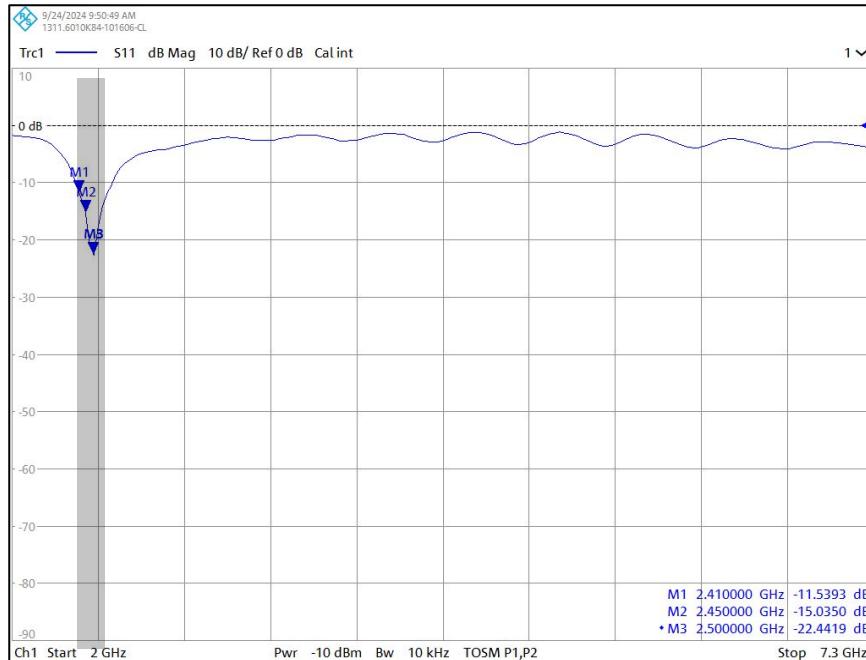


Antenna Test Setup

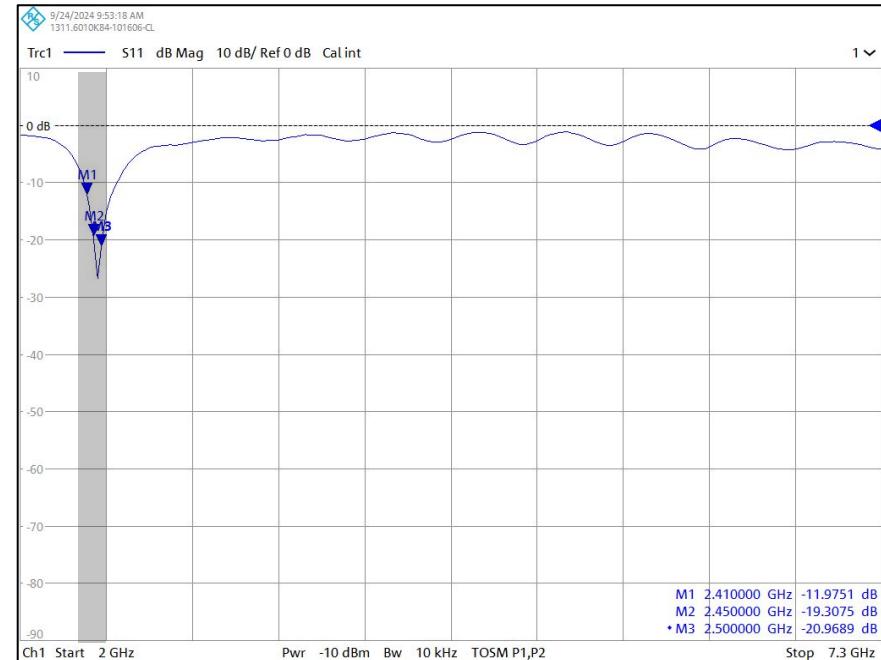


Top Views

Testing Results - Return Loss[dB]

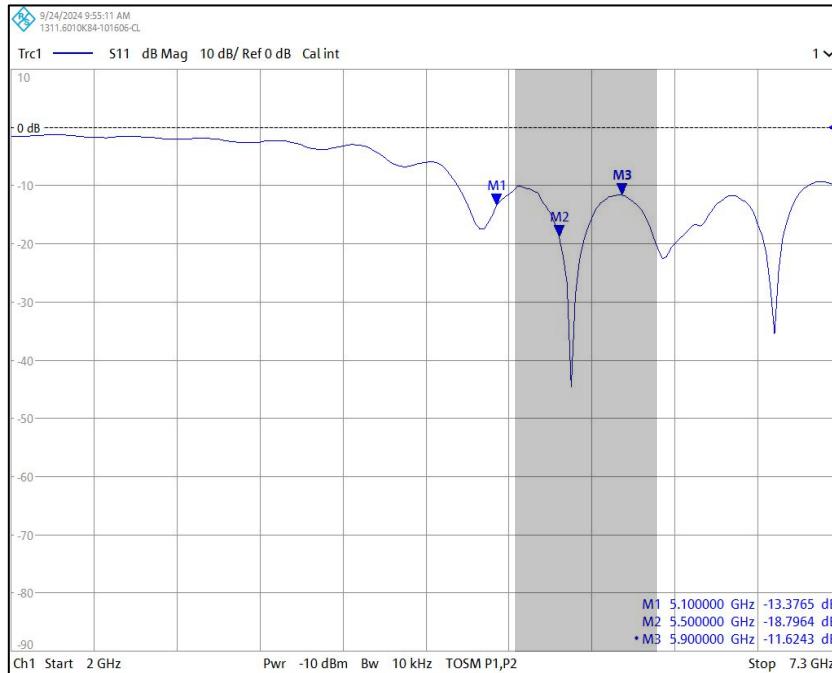


2.4GHz_Ant1

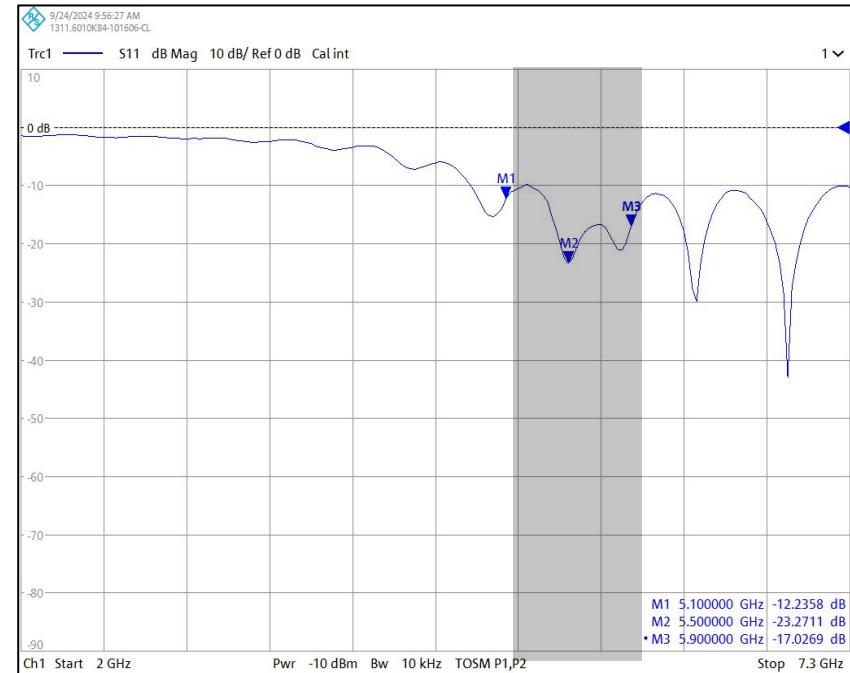


2.4GHz_Ant2

Testing Results - Return Loss[dB]

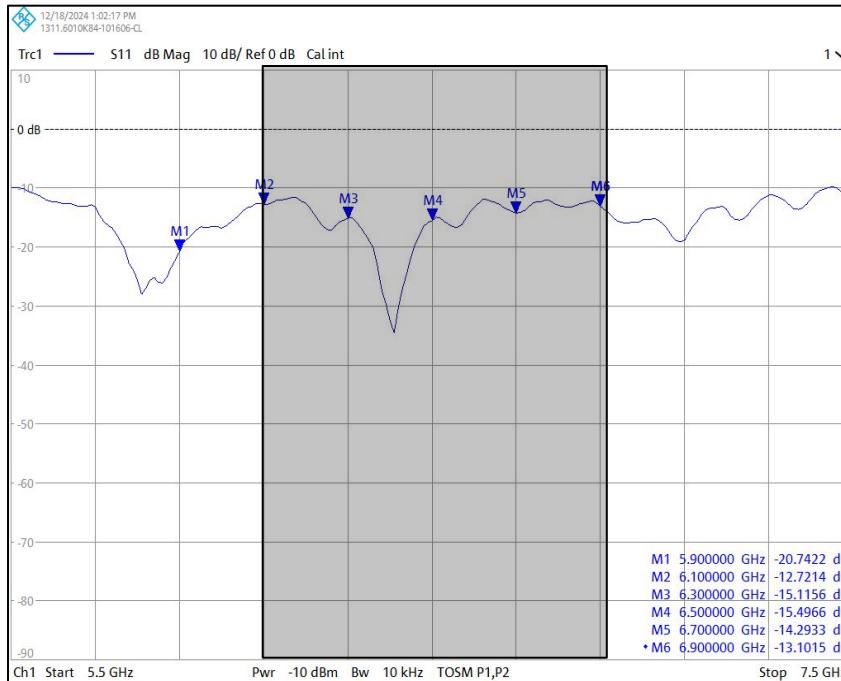


5GHz_Ant1

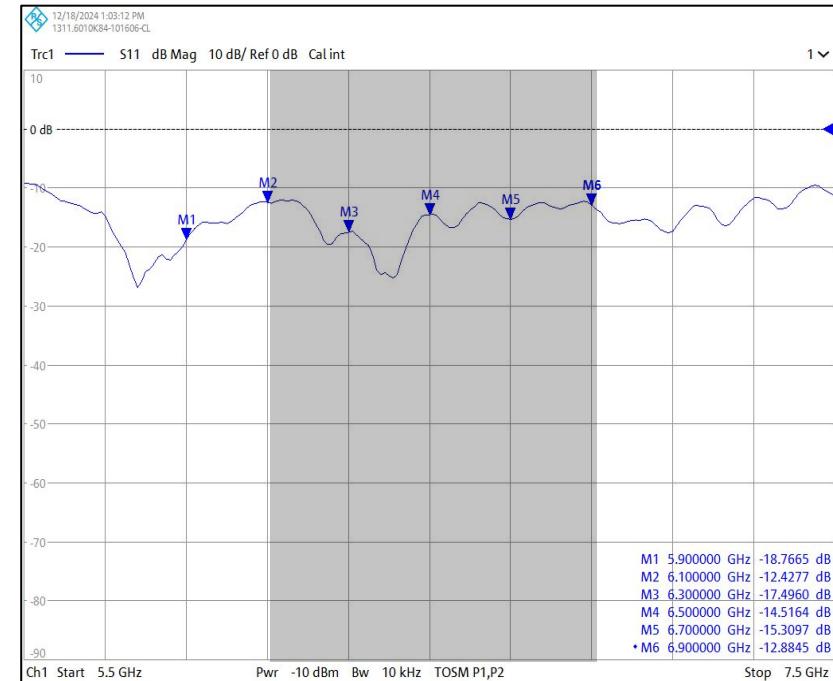


5GHz_Ant2

Testing Results - Return Loss[dB]

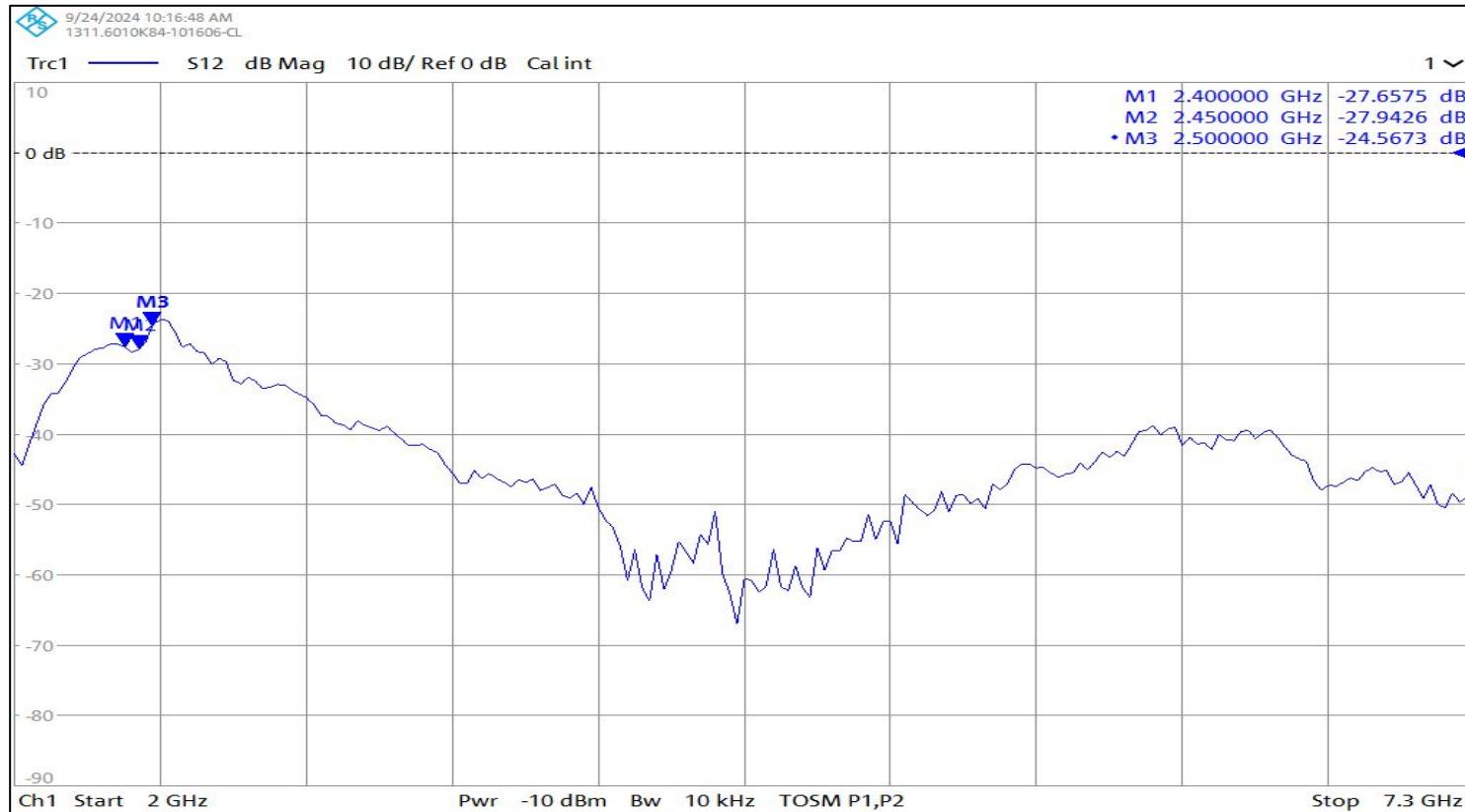


6GHz_Ant1

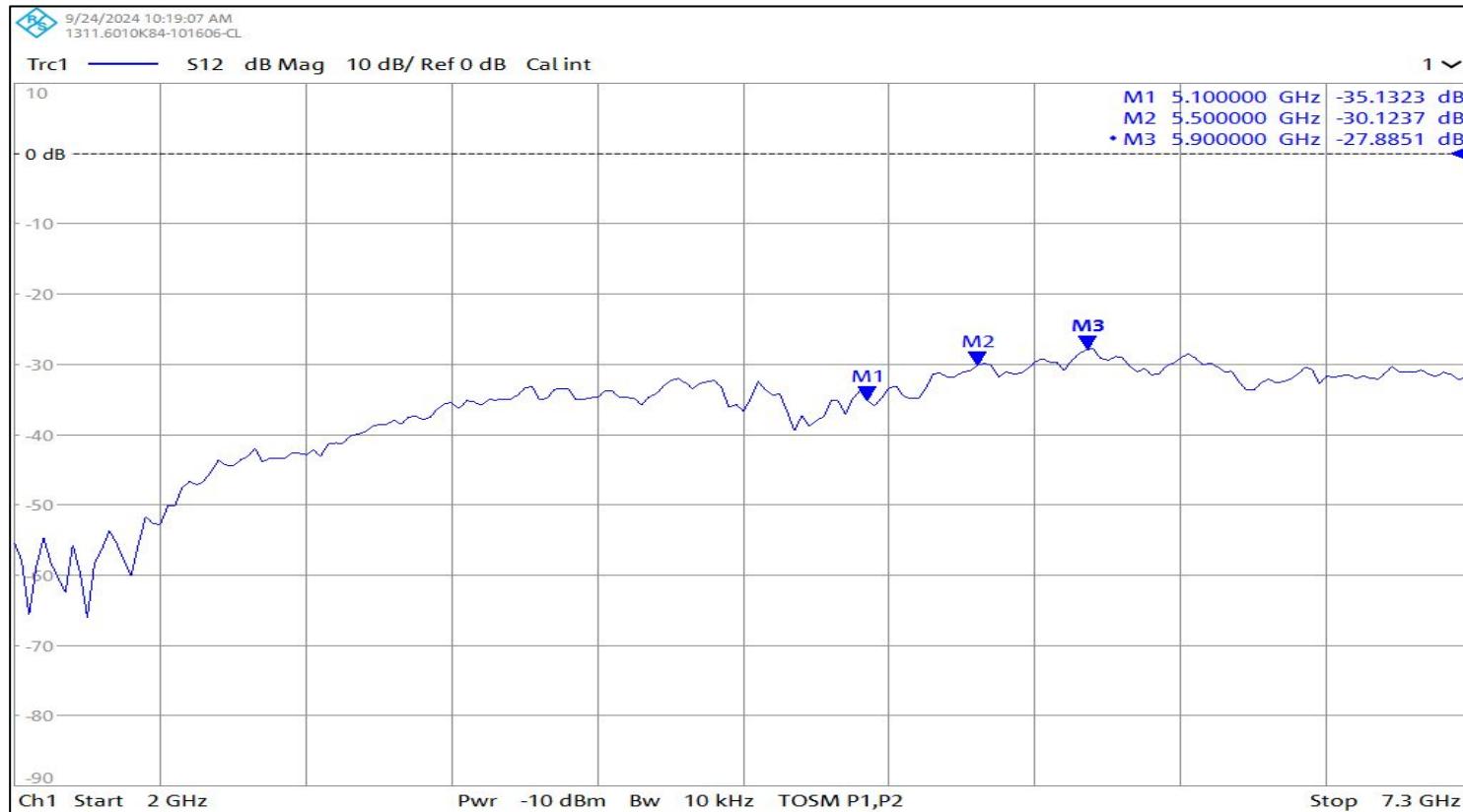


6GHz_Ant2

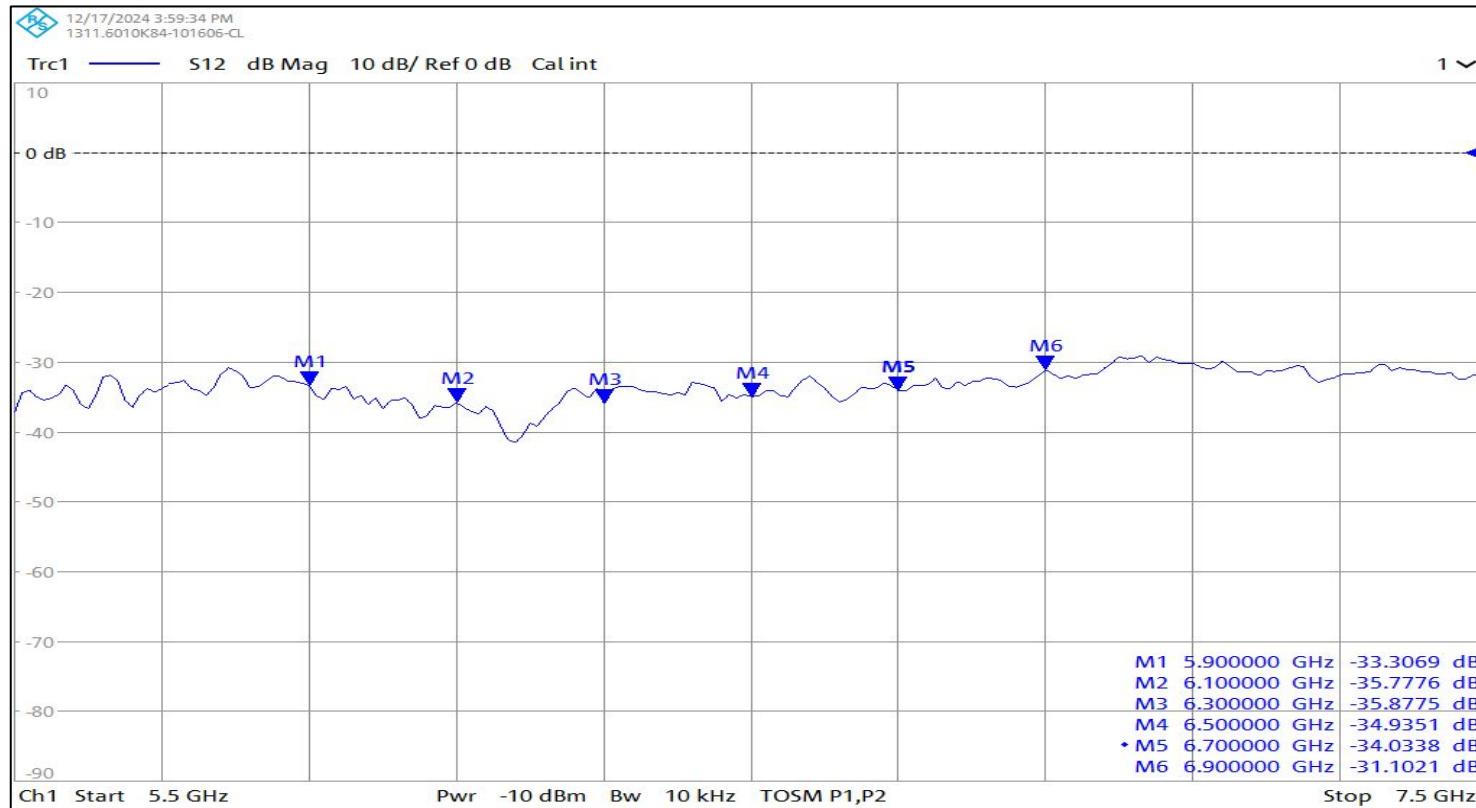
Isolation [dB] - 2.4 GHz (Ant1-Ant2)



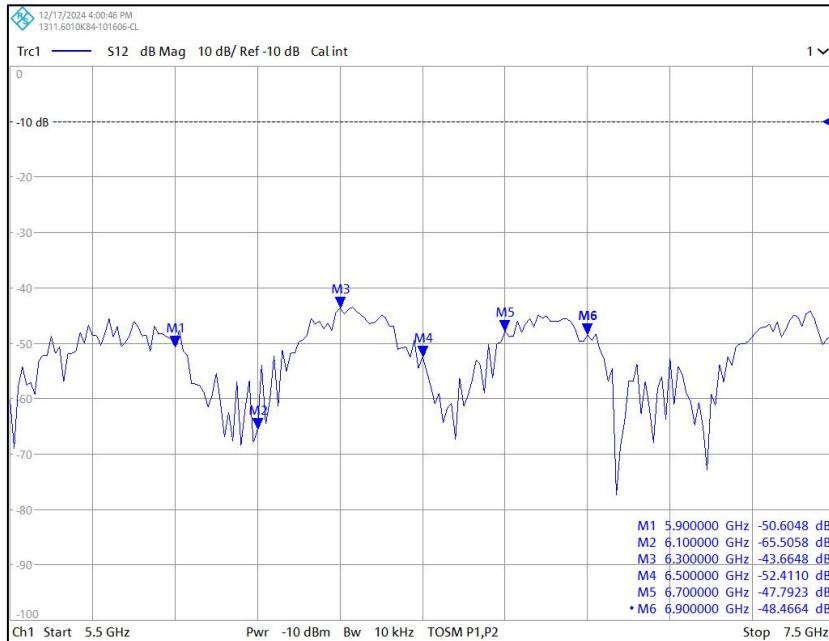
Isolation [dB] - 5 GHz (Ant1-Ant2)



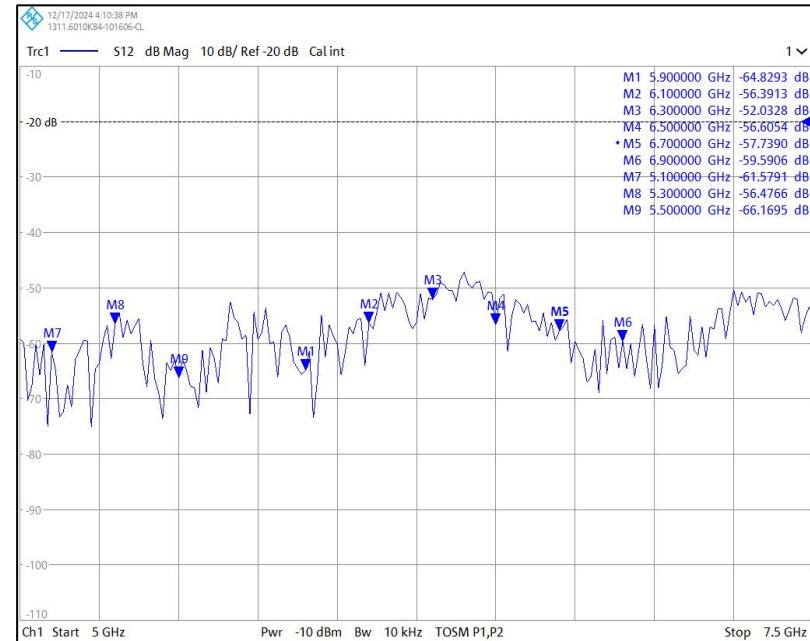
Isolation [dB] - 6 GHz (Ant1-Ant2)



Isolation [dB] - (5 GHz - 6 GHz)

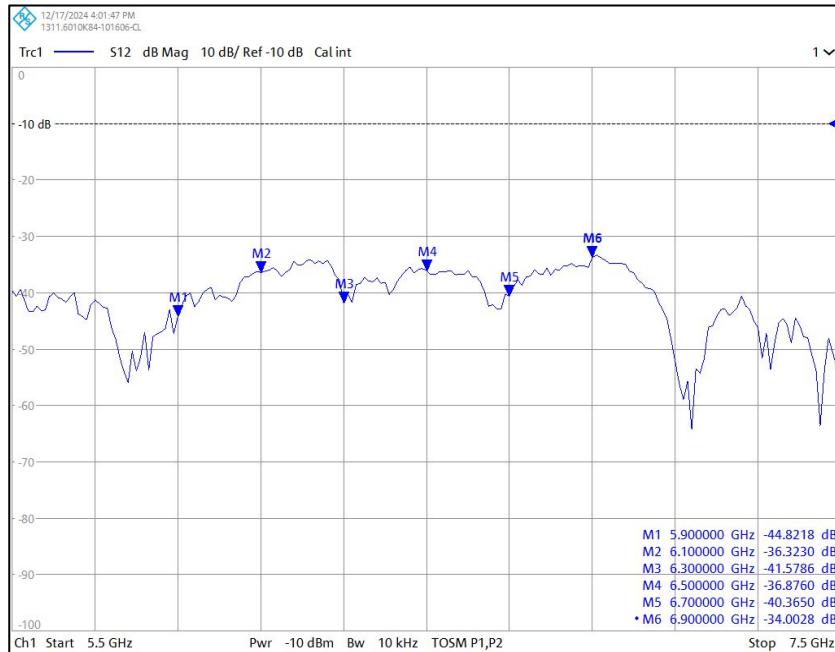


5GHz_Ant1- 6GHz
Ant1

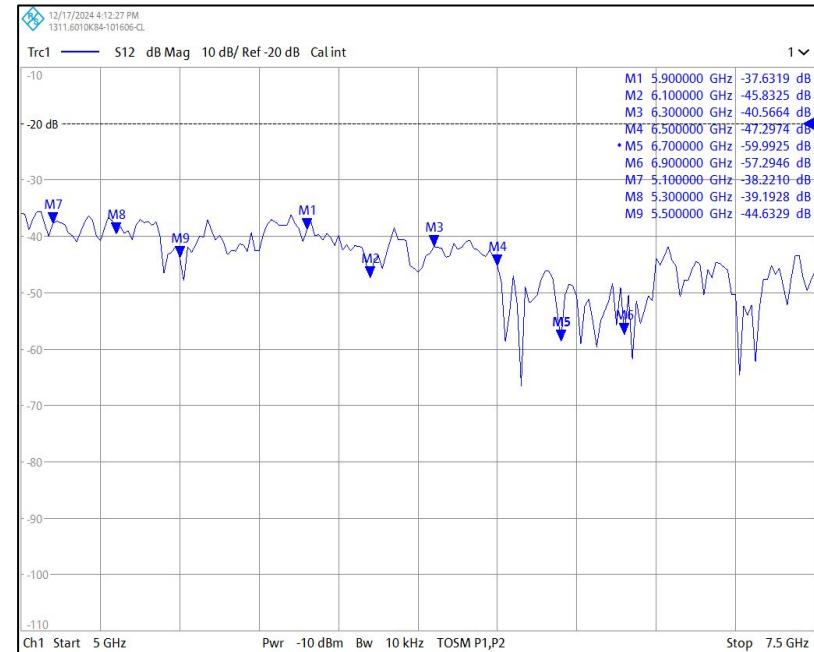


5GHz_Ant1- 6GHz
Ant2

Isolation [dB] - (5 GHz - 6 GHz)

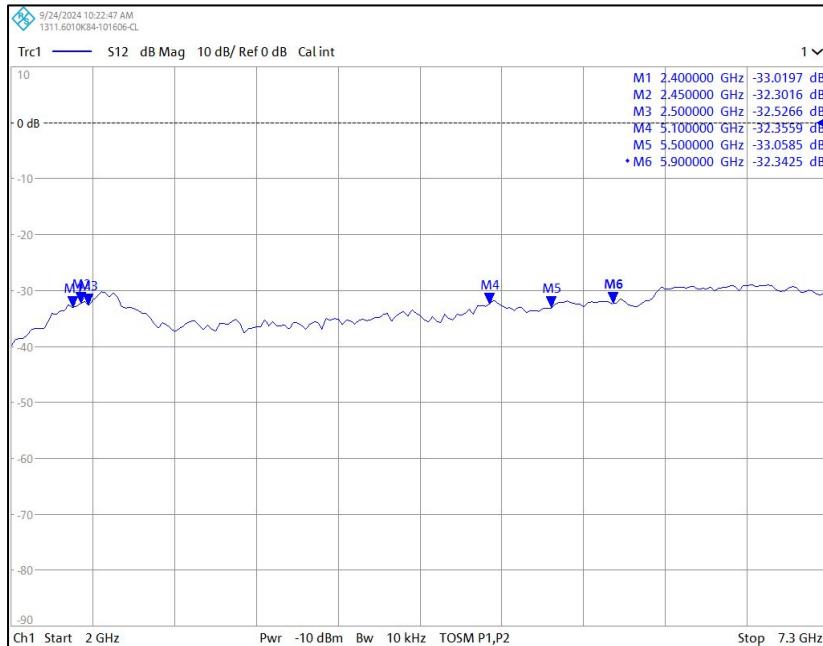


5GHz_Ant2- 6GHz
Ant1

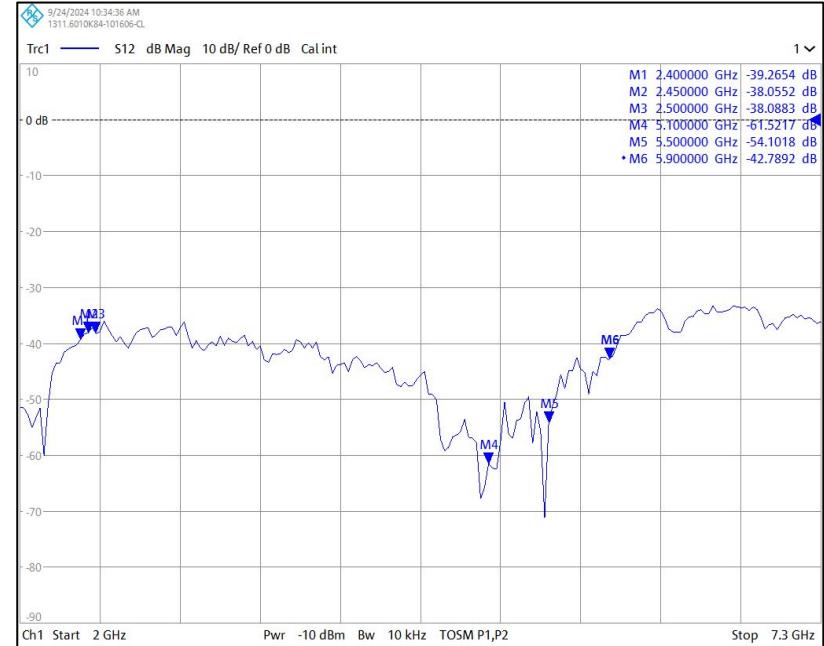


5GHz_Ant2- 6GHz
Ant2

Isolation [dB] - (5 GHz - 2.4 GHz)

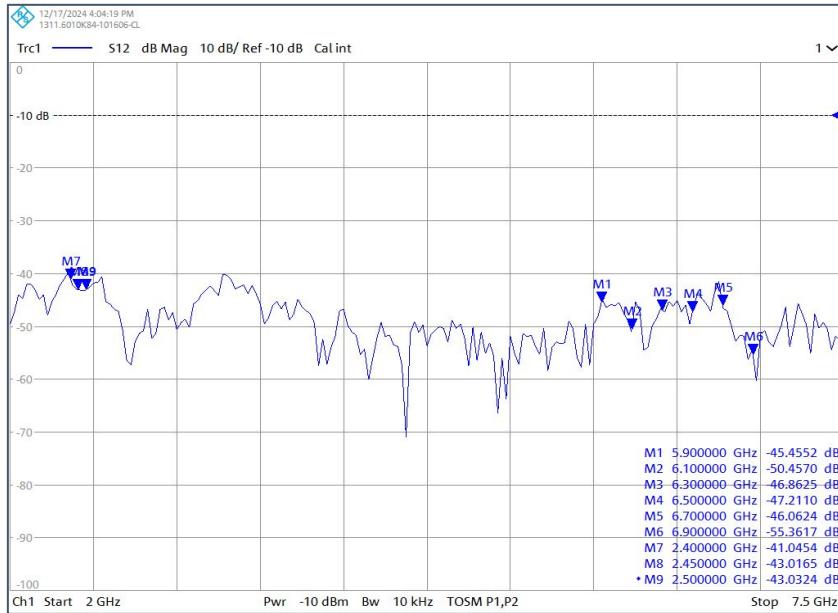


5GHz_Ant1- 2.4GHz Ant1

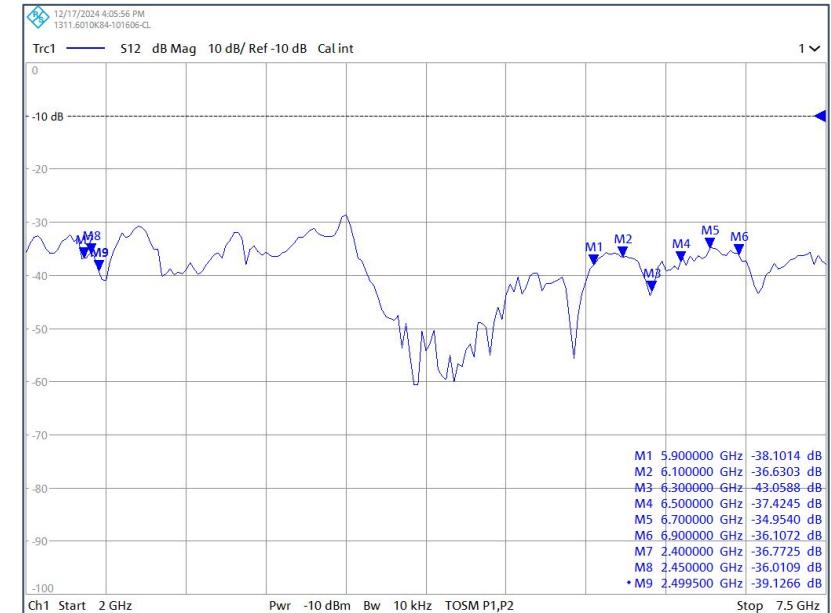


5GHz_Ant1- 2.4GHz Ant2

Isolation [dB] - (6 GHz - 2.4 GHz)

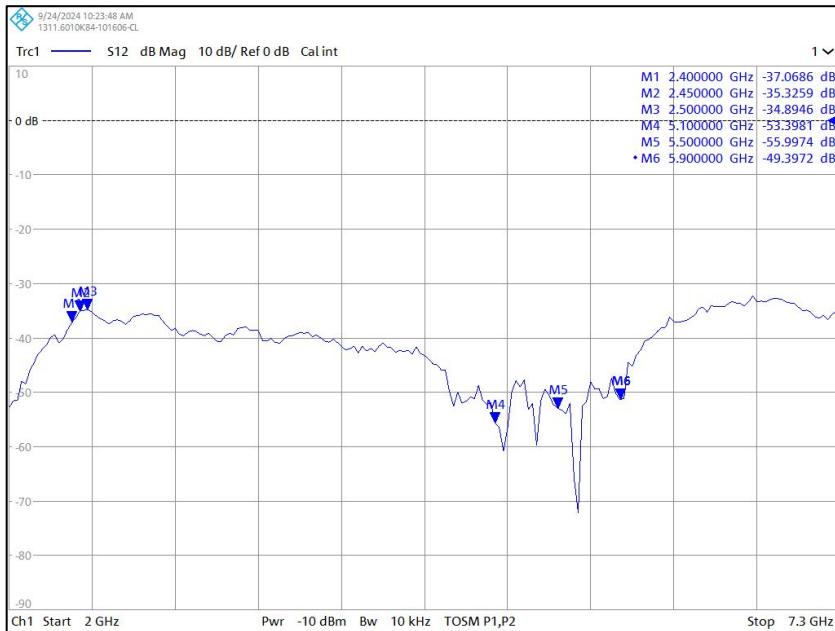


6GHz_Ant1- 2.4GHz Ant1

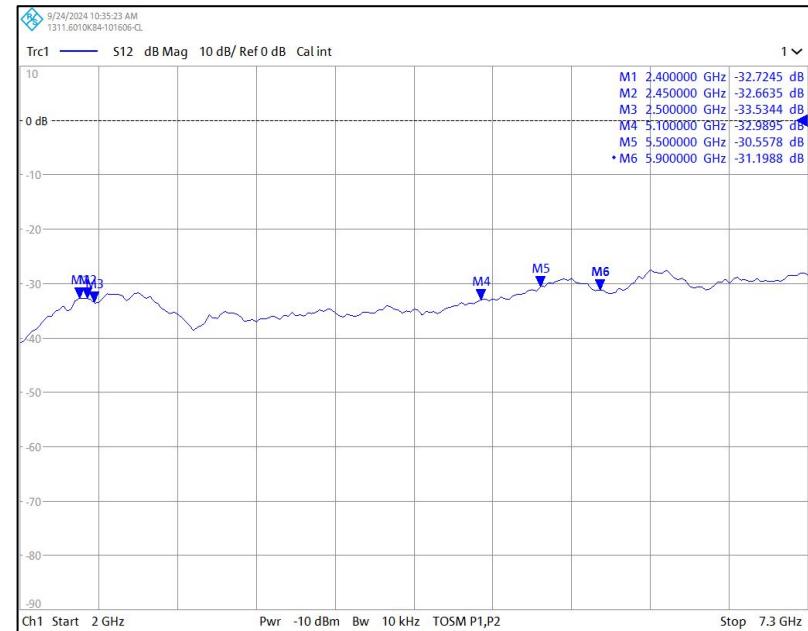


6GHz_Ant1- 2.4GHz Ant2

Isolation [dB] - (5 GHz - 2.4 GHz)

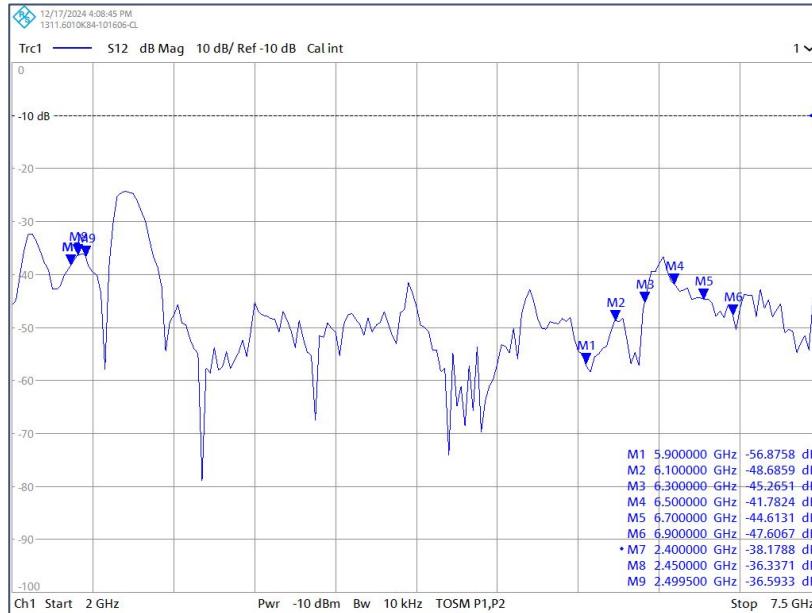


5GHz_Ant2- 2.4GHz Ant1

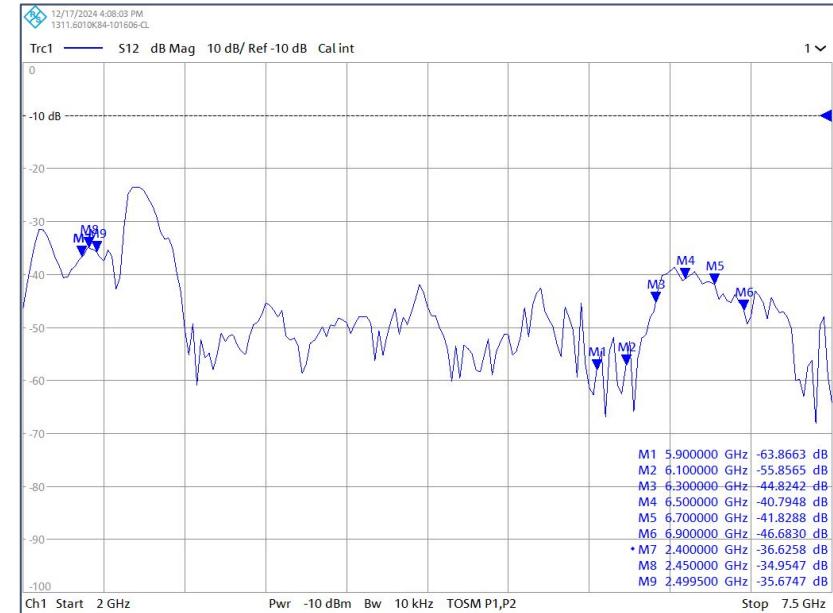


5GHz_Ant2- 2.4GHz Ant2

Isolation [dB] - (6 GHz - 2.4 GHz)



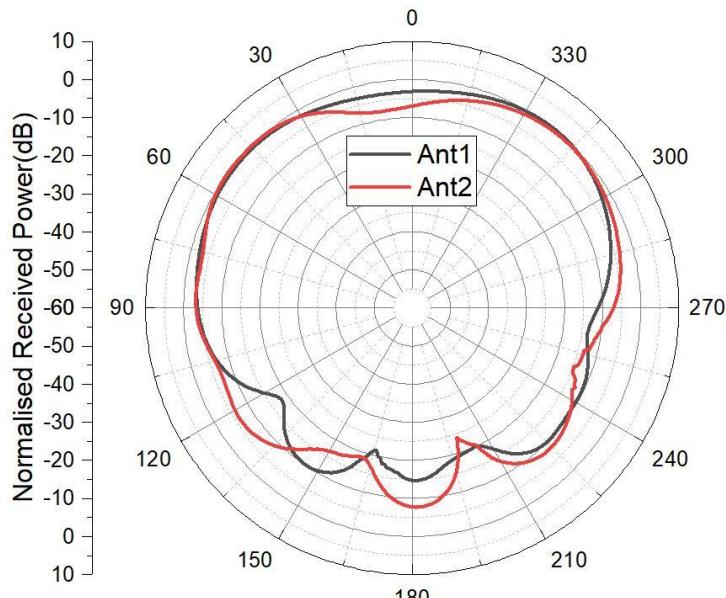
6GHz_Ant2- 2.4GHz_Ant1



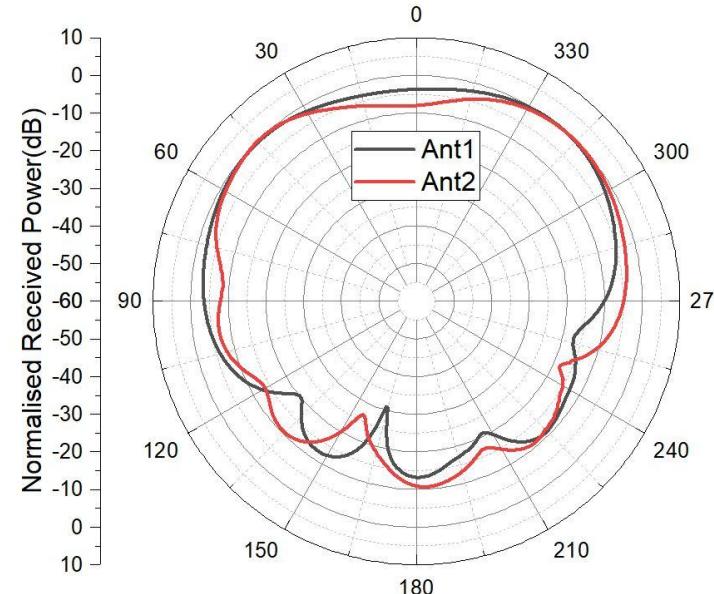
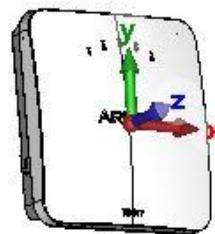
6GHz_Ant2- 2.4GHz_Ant2

2.4GHz Antenna

2D Radiation Pattern

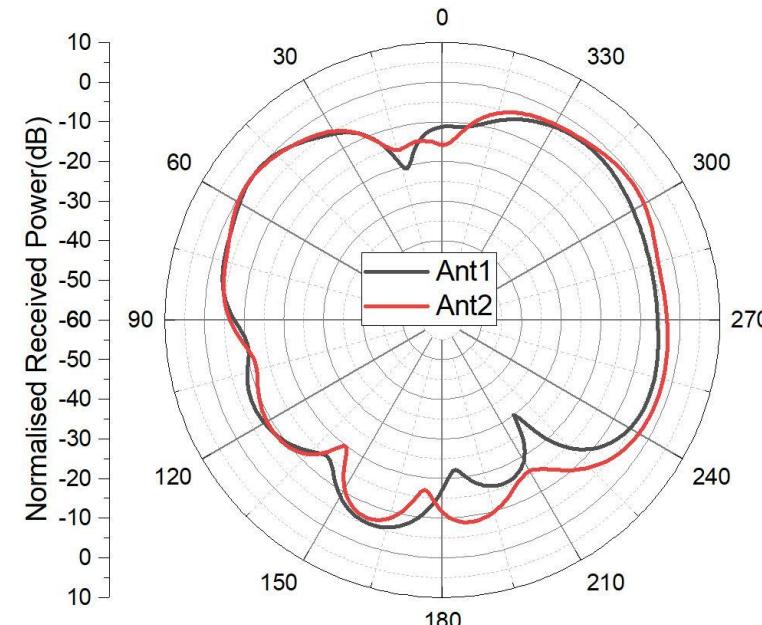
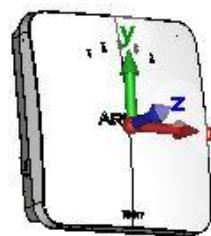
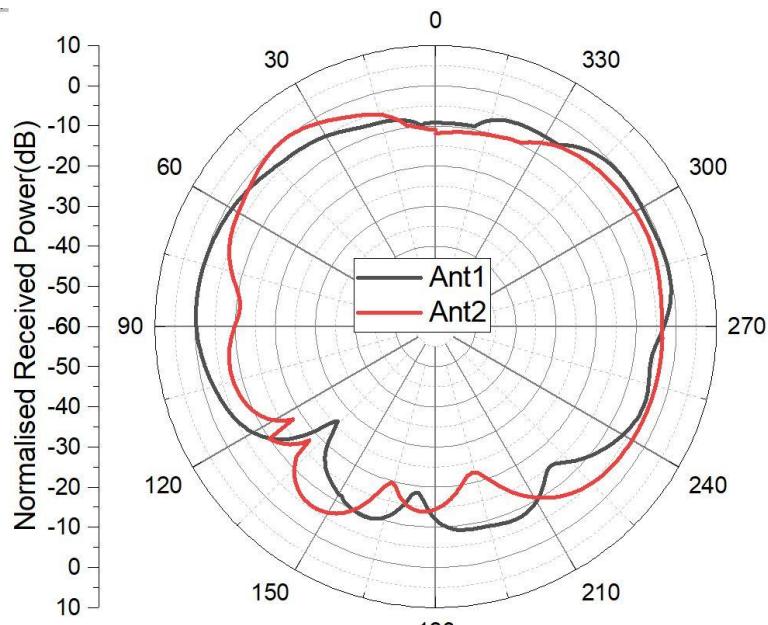


XZ plane 2.45 GHz

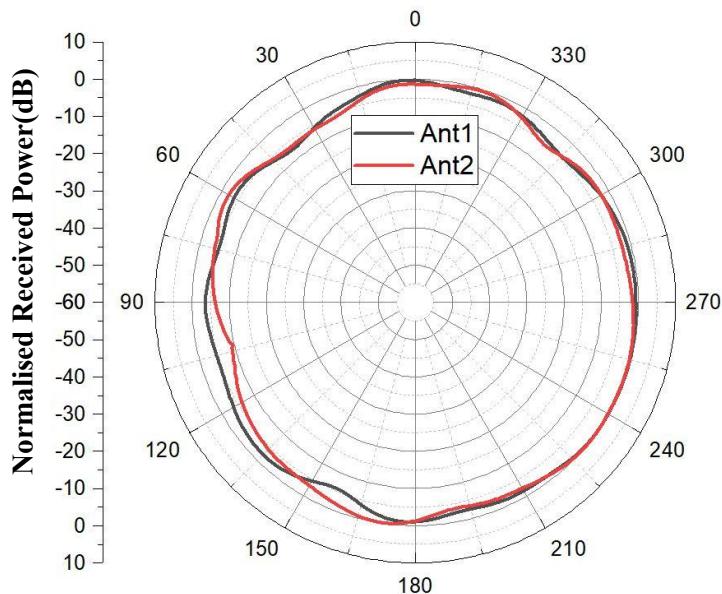


XZ plane 2.5 GHz

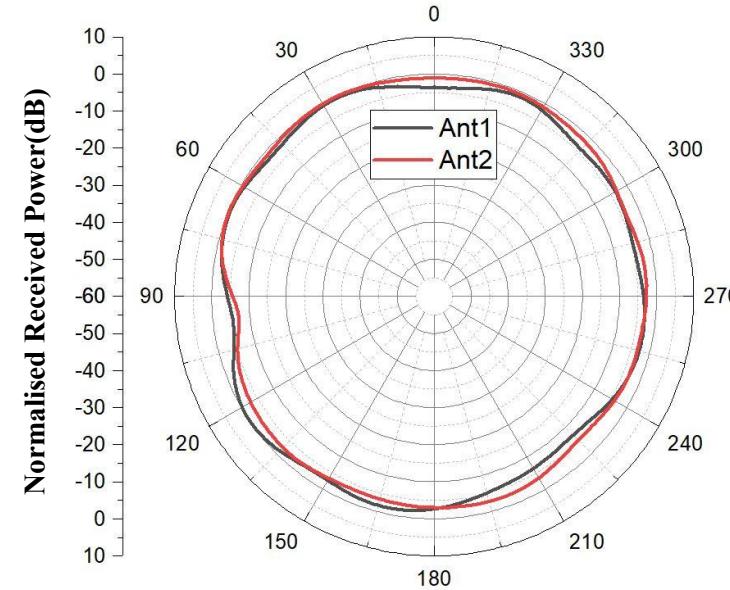
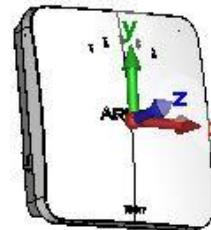
2D Radiation Pattern



2D Radiation Pattern



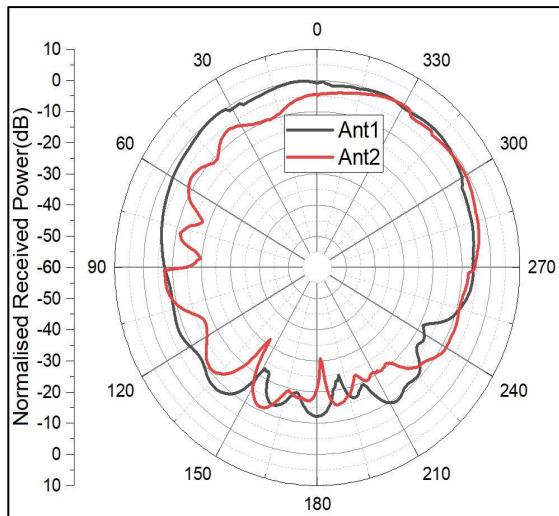
XY plane 2.45 GHz (Theta 90)



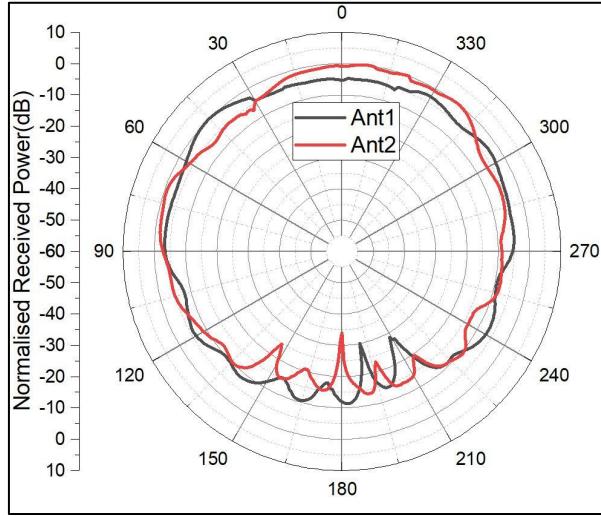
XY plane 2.5 GHz(Theta 90)

5 GHz Antenna

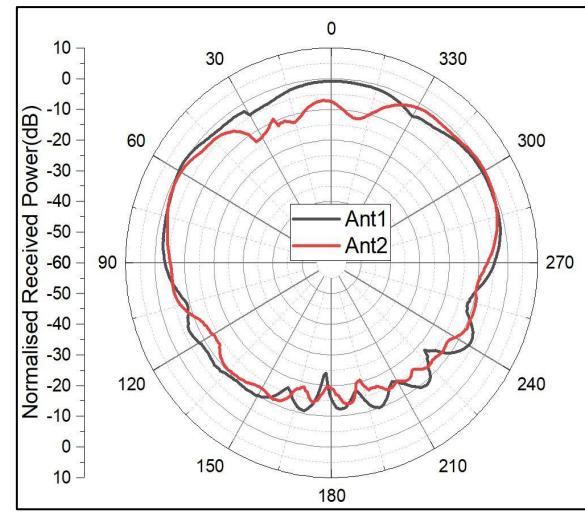
2D Radiation Pattern



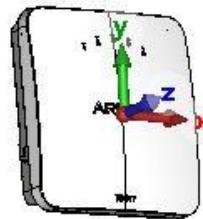
XZ plane 5.1 GHz



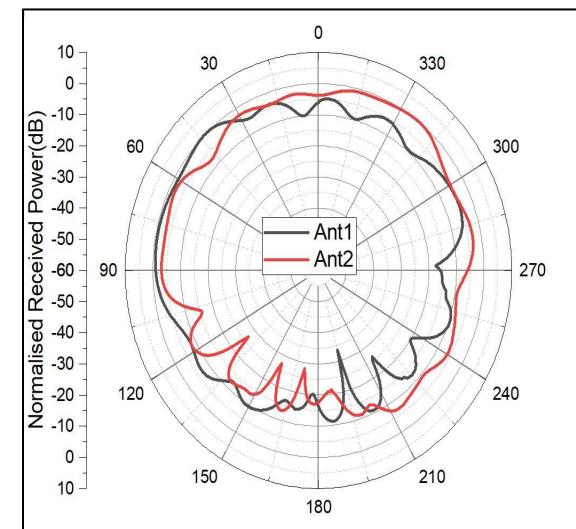
XZ plane 5.5 GHz



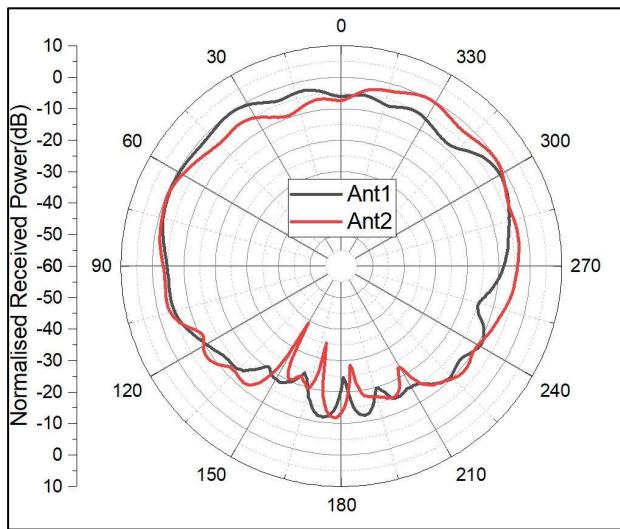
XZ plane 5.9 GHz



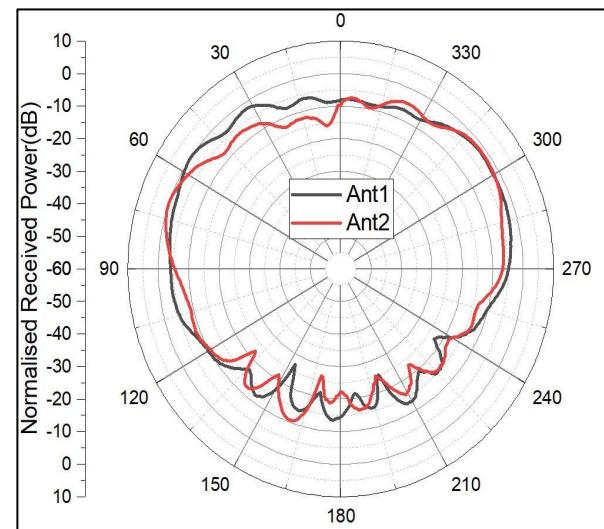
2D Radiation Pattern



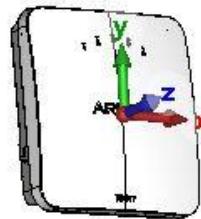
YZ plane 5.1 GHz



YZ plane 5.5 GHz

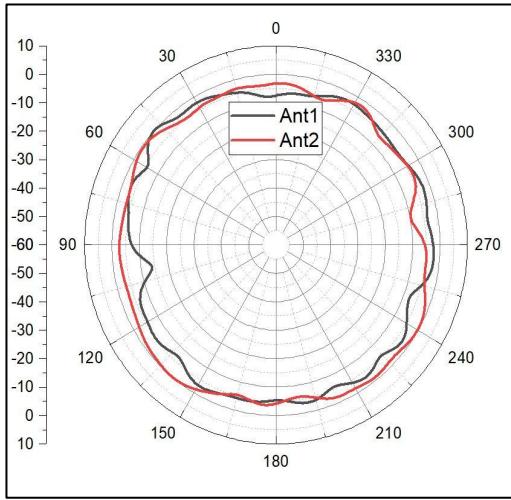


YZ plane 5.9 GHz



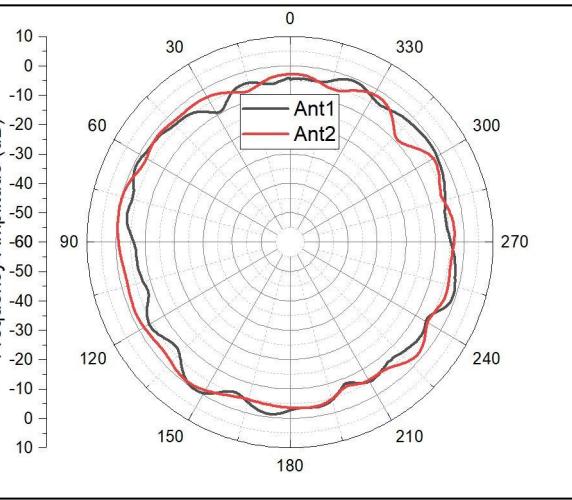
2D Radiation Pattern

Normalised Received Power(dB)



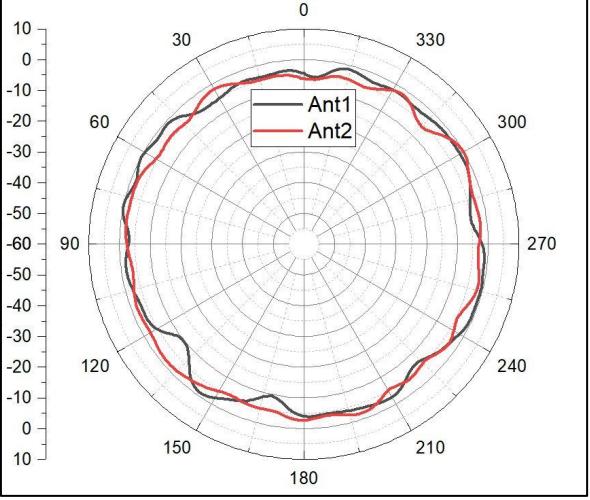
XY plane 5.1 GHz

Normalised Received Power(dB)

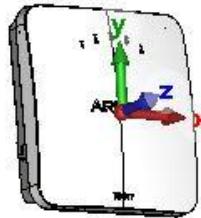


XY plane 5.5 GHz

Normalised Received Power(dB)

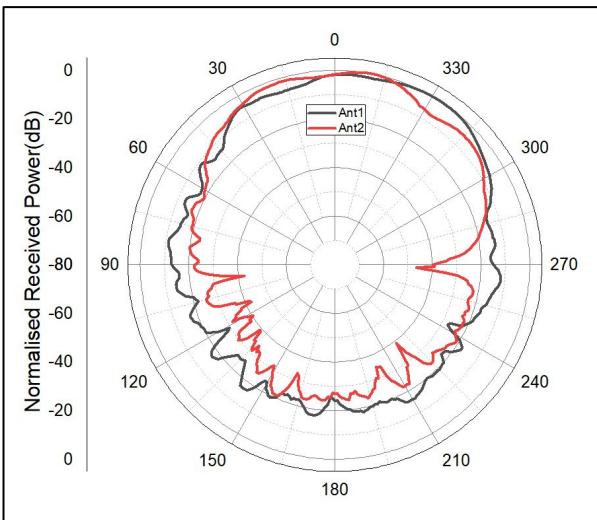


XY plane 5.9 GHz

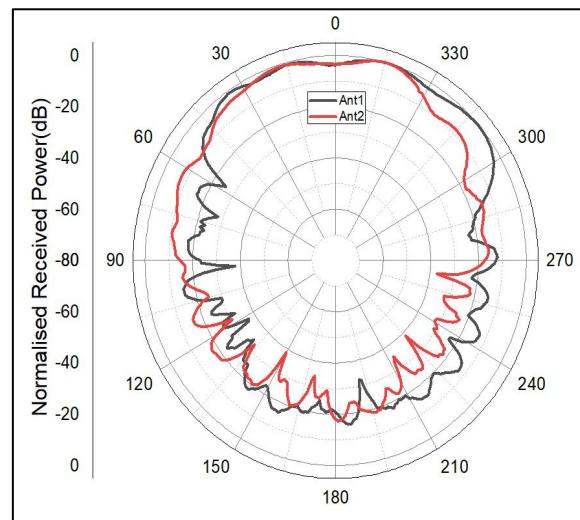


6 GHz Antenna

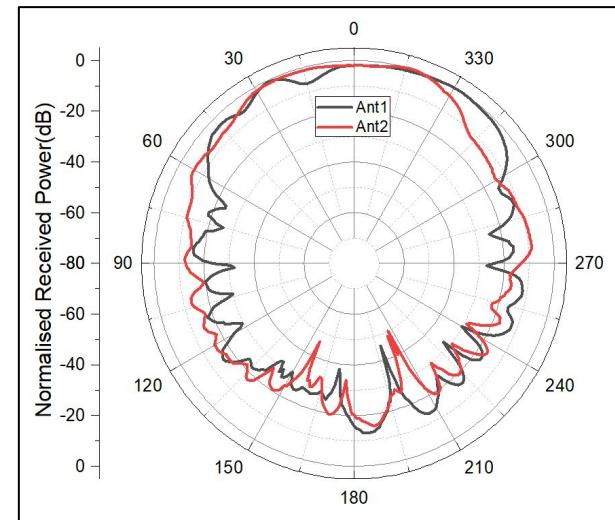
2D Radiation Pattern



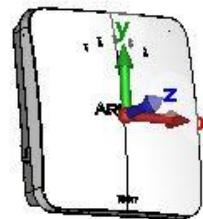
XZ plane 6.1 GHz



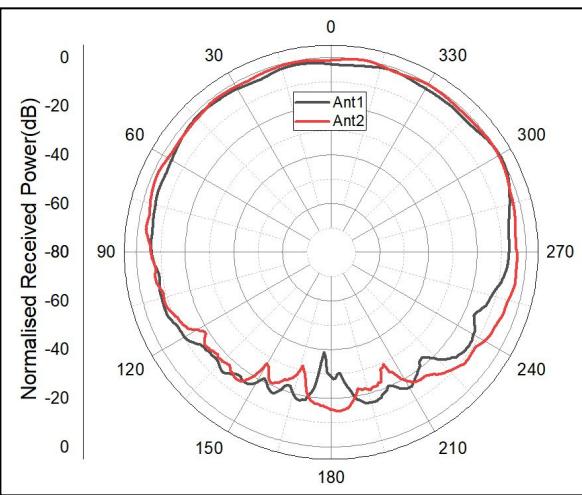
XZ plane 6.5 GHz



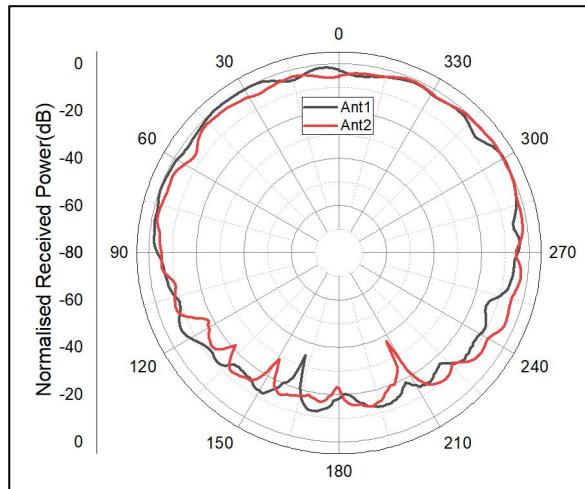
XZ plane 6.9 GHz



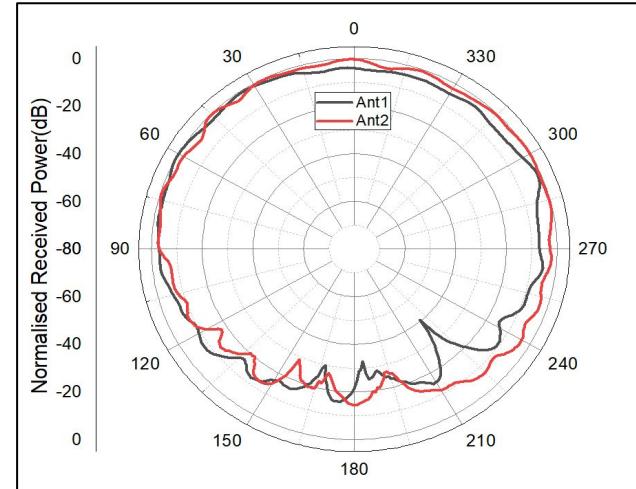
2D Radiation Pattern



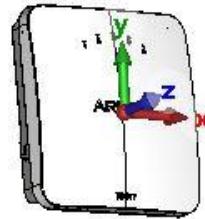
YZ plane 6.1 GHz



YZ plane 6.5 GHz



YZ plane 6.9 GHz



Antenna Passive Parameters

2.4 GHz_Ant1

Frequency(GHz)	Return Loss(dB)	VSWR	Gain(dB)
2.45	-15.03	1.43	4.789
2.5	-22.45	1.16	4.684

2.4 GHz_Ant2

Frequency(GHz)	Return Loss(dB)	VSWR	Gain(dB)
2.45	-19.04	1.25	4.57
2.5	-20.97	1.19	4.89

5 GHz_Ant1

Frequency(GHz)	Return Loss(dB)	VSWR	Gain(dB)
5.1	-13.38	1.54	4.81
5.5	-18.8	1.25	5.438
5.9	-11.63	1.71	5.736

5 GHz_Ant2

Frequency(GHz)	Return Loss(dB)	VSWR	Gain(dB)
5.1	-12.24	1.64	5.34
5.5	-23.28	1.14	5.165
5.9	-17.03	1.32	6.207

6 GHz_Ant1

Frequency(GHz)	Return Loss(dB)	VSWR	Gain(dB)
6.1	-12.72	1.601	5.685
6.5	-15.5	1.40	5.349
6.9	-13.1	1.56	6.038

6 GHz_Ant2

Frequency(GHz)	Return Loss(dB)	VSWR	Gain(dB)
6.1	-12.42	1.62	6.186
6.5	-14.5	1.46	5.889
6.9	-12.88	1.58	5.9

Measured Antenna Efficiency

Antenna radiation efficiency (η) is the ratio of radiated power to input power, given by $\eta=G/D$, where G is the gain and D is the directivity.



2.4 GHz

Frequency(GHz)	Efficiency(dB)		Efficiency(%)	
	Ant 1	Ant 2	Ant 1	Ant 2
2.45	-0.7	-1	85.11	79.4
2.5	-1.15	-1.25	76.736	74.989

5 GHz

Frequency(GHz)	Efficiency(dB)		Efficiency(%)	
	Ant 1	Ant 2	Ant 1	Ant 2
5.1	-1.24	-0.84	75.162	82.414
5.5	-1.06	-1.06	78.34	78.34
5.9	-1.12	-1.22	77.26	75.5

6 GHz

Frequency(GHz)	Efficiency(dB)		Efficiency(%)	
	Ant 1	Ant 2	Ant 1	Ant 2
6.1	-0.92	-0.91	80.91	81.1
6.5	-1.06	-1.15	78.34	76.74
6.9	-1.12	-1.19	77.27	76.03

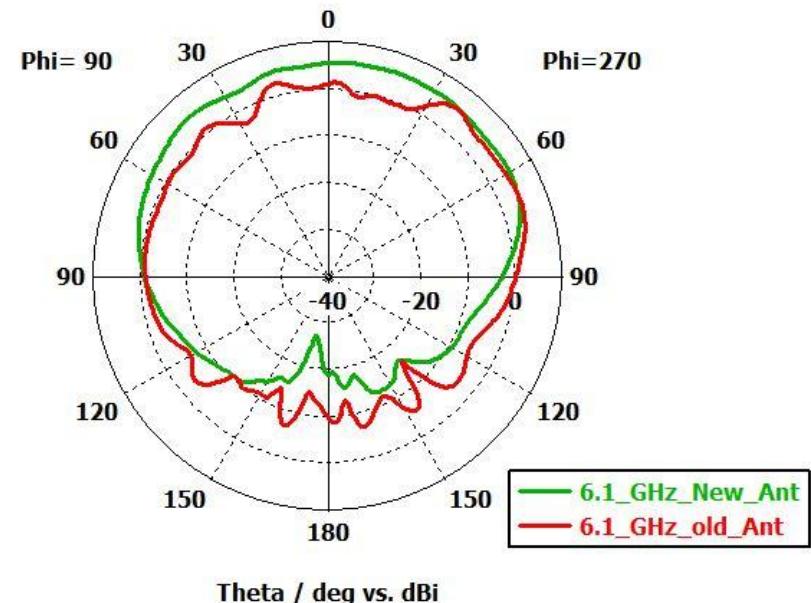
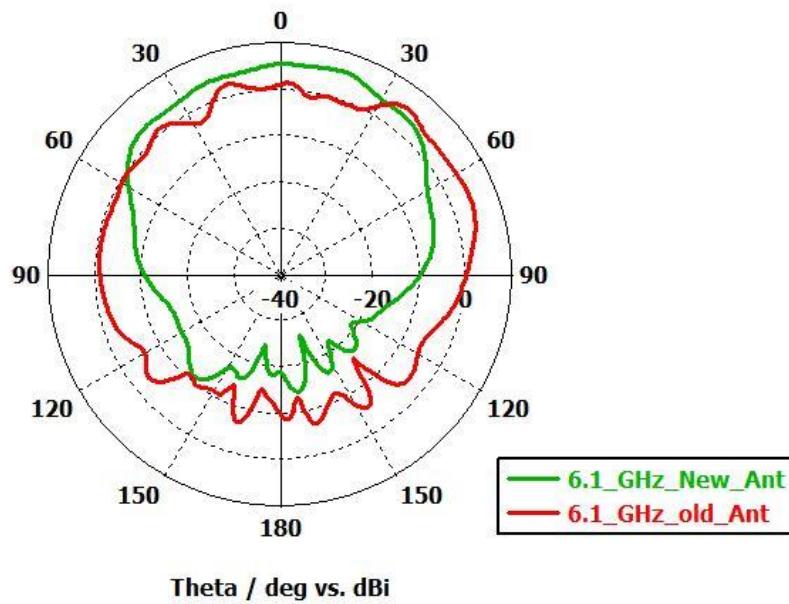
Summarized Characteristics

<u>Sl. No.</u>	<u>Parameters</u>	<u>For 2.4 GHz</u>	<u>For 5 GHz</u>	<u>For 6 GHz</u>
1	Number of Antennas	2	2	2
2	Exact Frequency Bands of Operation	2400 MHz - 2483 MHz	4900 MHz – 5850 MHz	5925 MHz – 7125 MHz
3	Return Loss	< -10 dB	< -10 dB	< -10 dB
4	VSWR	< 1.9	< 1.9	< 1.9
5	10dB Bandwidth	83 MHz	950 MHz	1200 MHz
6	Isolation	< - 20 dB	< - 25 dB	< - 25 dB
7	Peak Gain of Individual Antenna	~ 4.5 dBi	~ 5.5 dBi	~ 5.5 dBi
8	Polarization	Linear	Linear	Linear
9	Element Dimensions~ (L x w)mm	42.75 x 11 mm	21.4 x 9.1 mm	21 x 11 mm

Pros & Cons Comparison

Stamped Metal	PCB
For both planes (XZ/YZ) the partners will be uniform	For one plane (XZ/YZ) radiation levels will be more and for another plane it will be less near to ceiling
At broadside, the gain will be less (Standard nature of stamped monopoles)	At Broadside gain will be more (Nature of dipole with flat reflector)
Results in good areal coverage around the ceiling plane.	Around the ceiling plane power level are less (XY plane which comes across the roof)
Antenna material is metallic (Sheet metal tool)	PCB based radiator (Spacer tool will be used for mounting)
Unable to achieve 4KQAM within 1 meter of range due to low power at broadside. (Able to achieve at extreme close proximity)	Able to achieve 4KQAM

Pattern Comparison



Conclusion

- 2.4, 5 and 6 GHz customised antennas are designed and measured.
- All 6 antennas were placed on a 172 X 172 mm metallic plate.
- The placement is optimised for better isolation and radiation performance.
- The return loss and VSWR are meeting the specs.
- The gain of the antennas are as per simulated results.
- Isolation between antennas are as below:
 - Less than -25 dB between 6 GHz Antennas
 - Less than -25 dB between 5 GHz Antennas
 - Less than -20 dB between 2.4 GHz Antennas
 - Less than -20 dB between 5 GHz-6 GHz , 5 GHz-2.4 GHz and 2.4 GHz-6 GHz Antennas

Thank You