

VVDN_Arista_C400_Antenna Measurement_A0-03

Premier Electronics Engineering & Manufacturing Company
Creating Opportunities & Transforming Lives !

18-12-2024

Required Antenna Specifications

| | |
|-------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Antenna & RF Cable | <ul style="list-style-type: none">o Frequency<ul style="list-style-type: none">▪ 2400 MHz – 2483 MHz▪ 4900 MHz – 5850 MHz▪ 5925 MHz – 7125 MHzo 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 GHzo Return loss<ul style="list-style-type: none">▪ ≥ 10 dBo Efficiency<ul style="list-style-type: none">▪ Single band efficiency of $\geq 75\%$ at all frequencies for internal antennaso 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 GHzo Polarisation<ul style="list-style-type: none">▪ Linear● RF Cable Insertion loss between module and antenna<ul style="list-style-type: none">o ≤ 0.5dB@2.4~2.4835 GHzo ≤ 1dB@4.9~5.85 GHzo ≤ 1dB@5.925~7.125 GHz |
|-------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

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 |

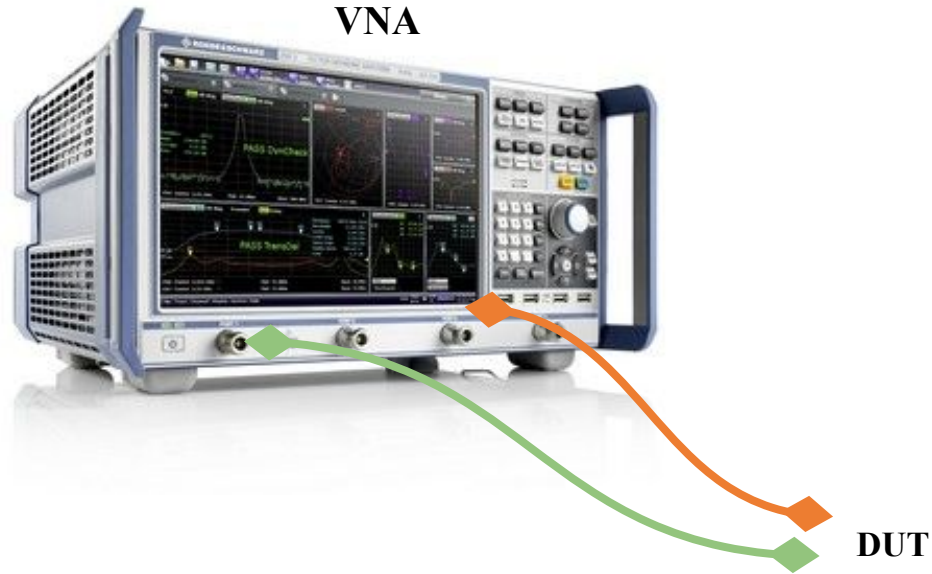
| Shielding Effectiveness | |
|------------------------------------|---------------------------|
| Frequency Range | 700MHz-7.5GHz |
| Shielding Effectiveness | >80dB |
| Test Procedure Standard | STD-IEEE-299/ MIL STD 285 |
| Size available for shielding shall | 15.5m x 4m x 4m |

| 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 |

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

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

Test Equipment

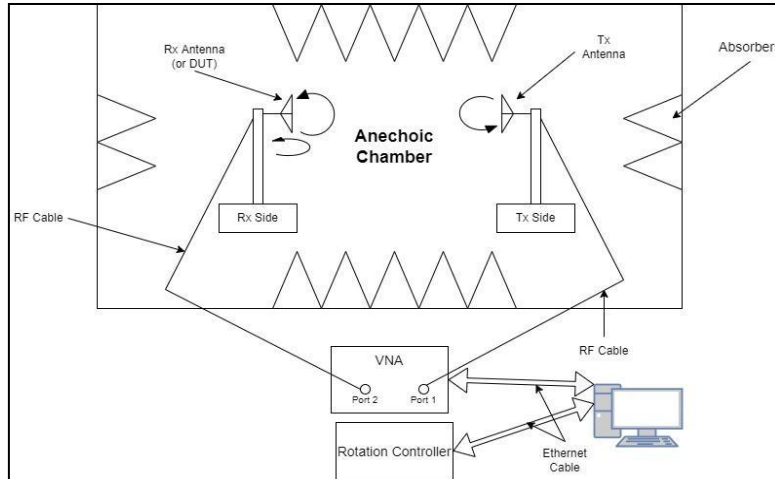


**Test Setup for Measurement of Return Loss,
VSWR and Isolation of Antenna**

| | |
|---------------------|-------------------|
| 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

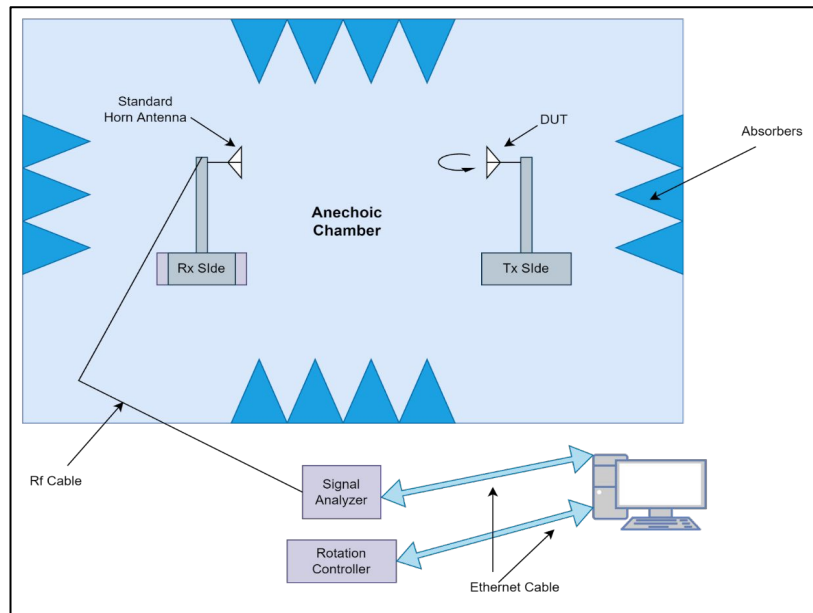
| | |
|----------------------------|----------------------------|
| Manufacturer | Rohde & Schwarz |
| Model No | ZNB40 |
| Operating frequency | 100 KHz to 40 GHz |
| Certificate No. | 20-921315-C |

Details of the Vector Network Analyzer (VNA)

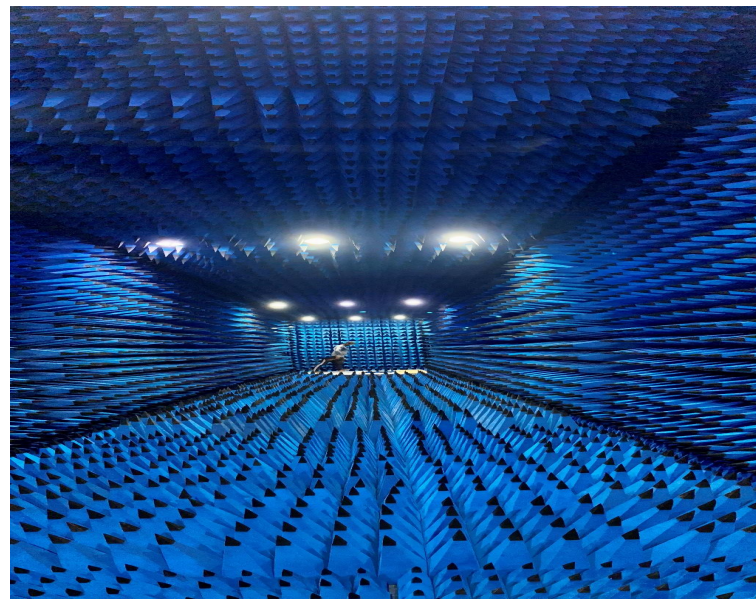
| | |
|---------------------|---------------------|
| Manufacturer | JV Micronics |
| Model No | DAC 3002 |

Details of the rotation controller

Anechoic Chamber (700MHz – 7.5GHz)

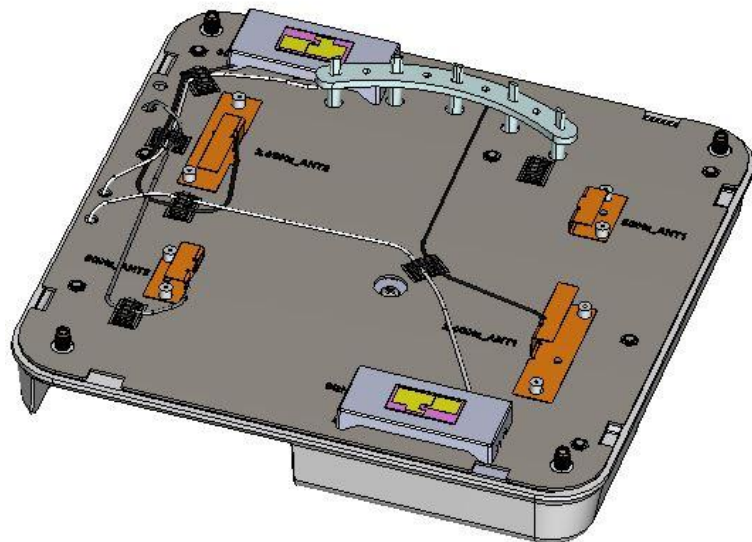
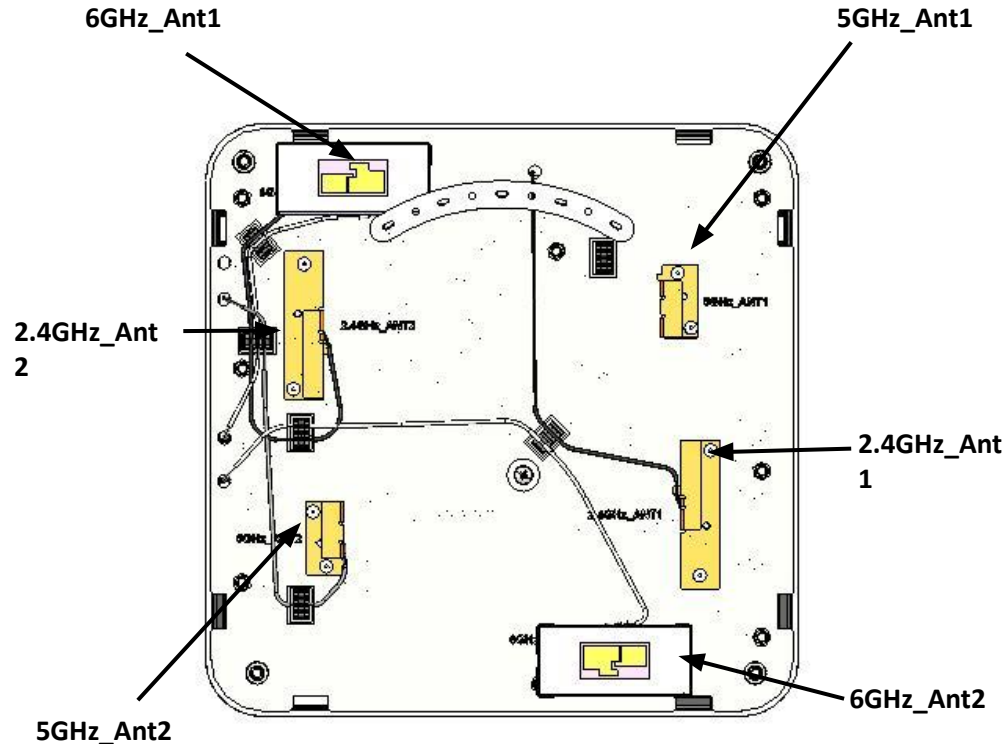


Block Diagram



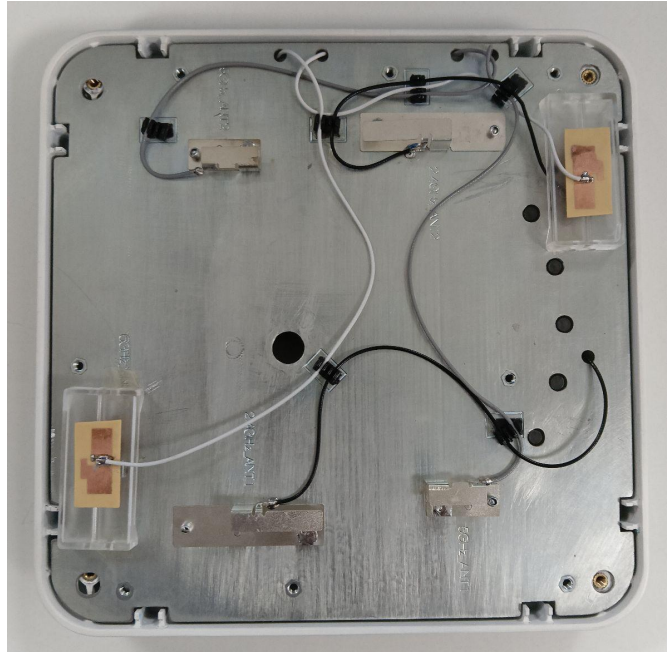
Chamber Inside View

Antenna Placement



Isometric & Top Views with Antenna Numberings

Antenna Placement

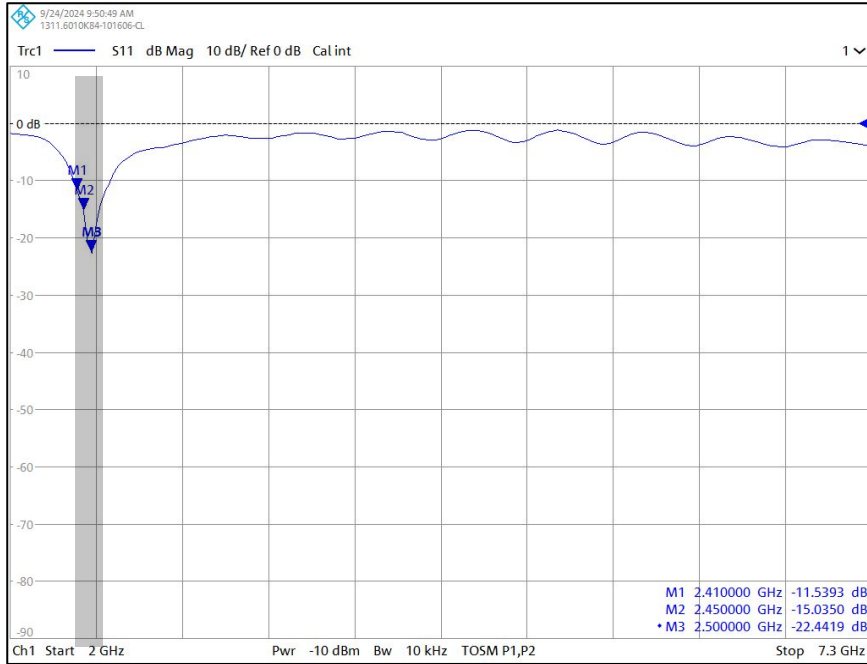


Antenna Test Setup

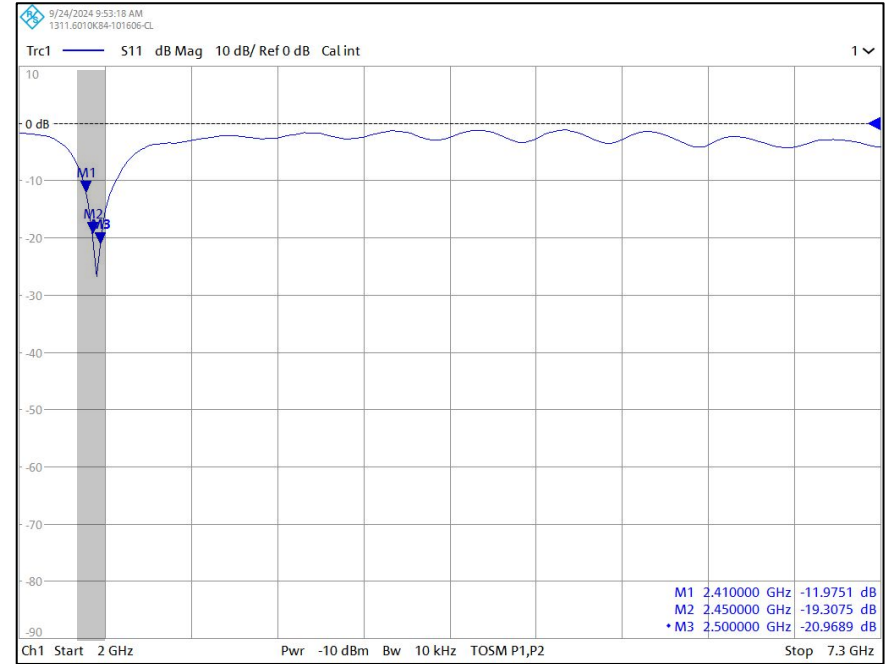


Top Views

Testing Results - Return Loss[dB]

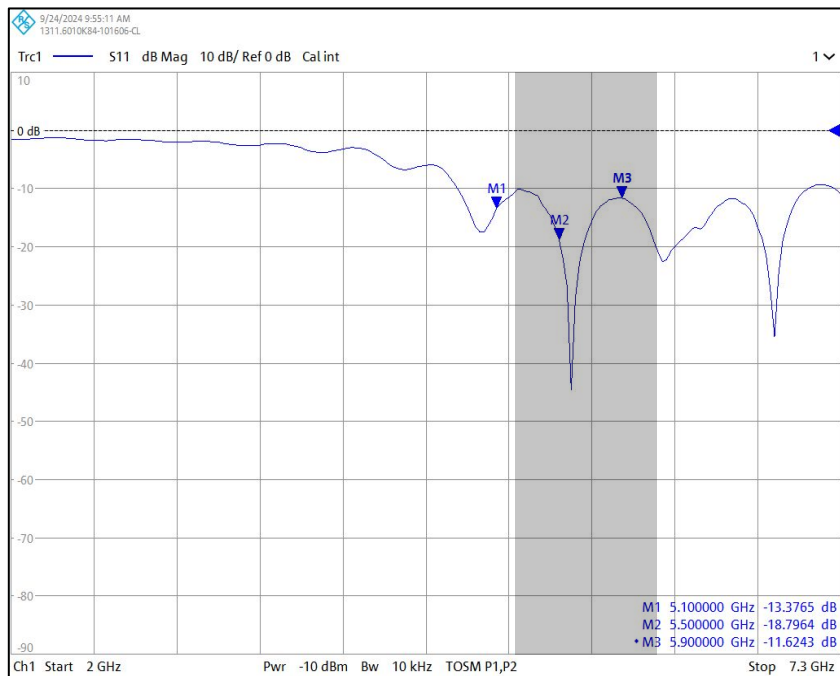


2.4GHz_Ant1

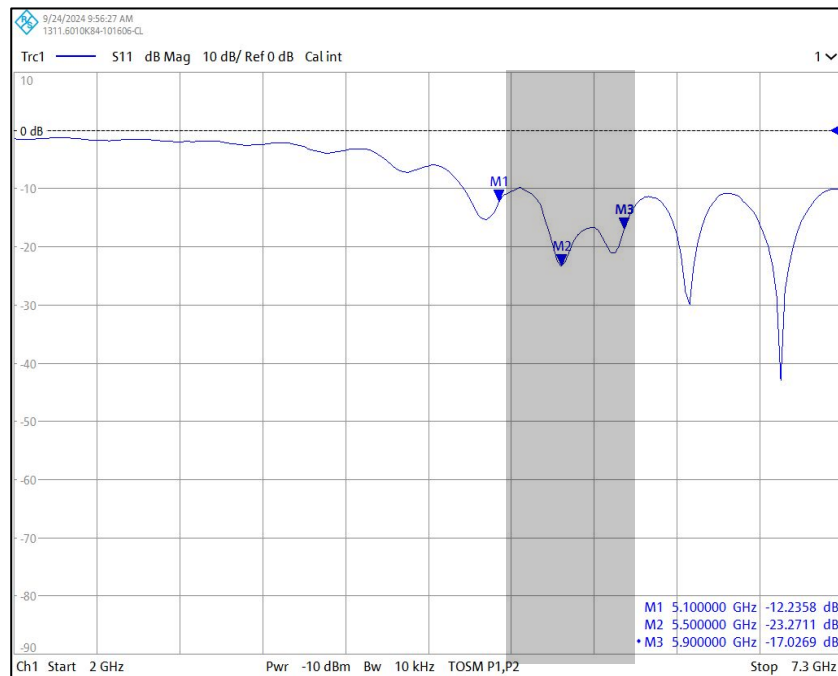


2.4GHz_Ant2

Testing Results - Return Loss[dB]

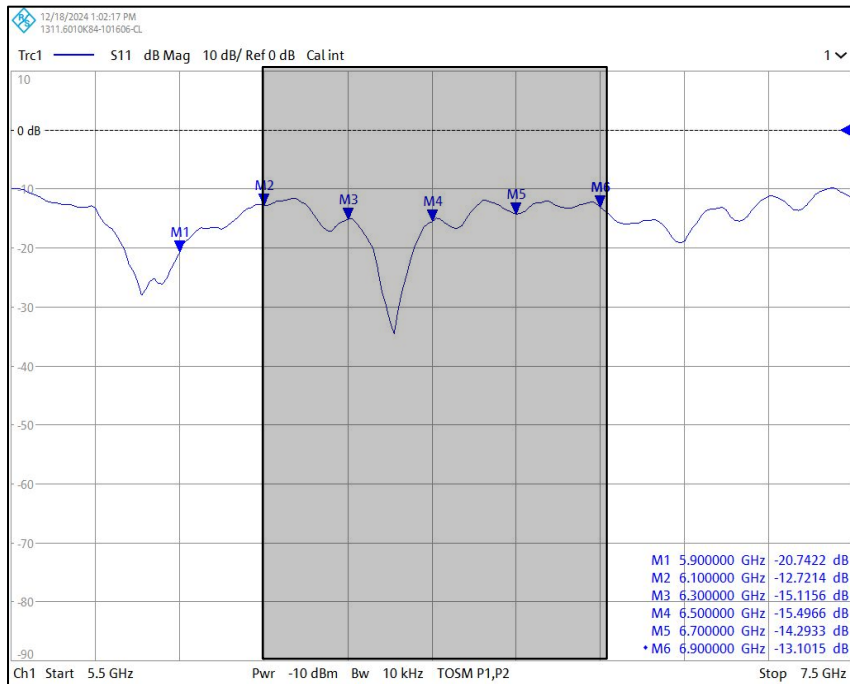


5GHz_Ant1

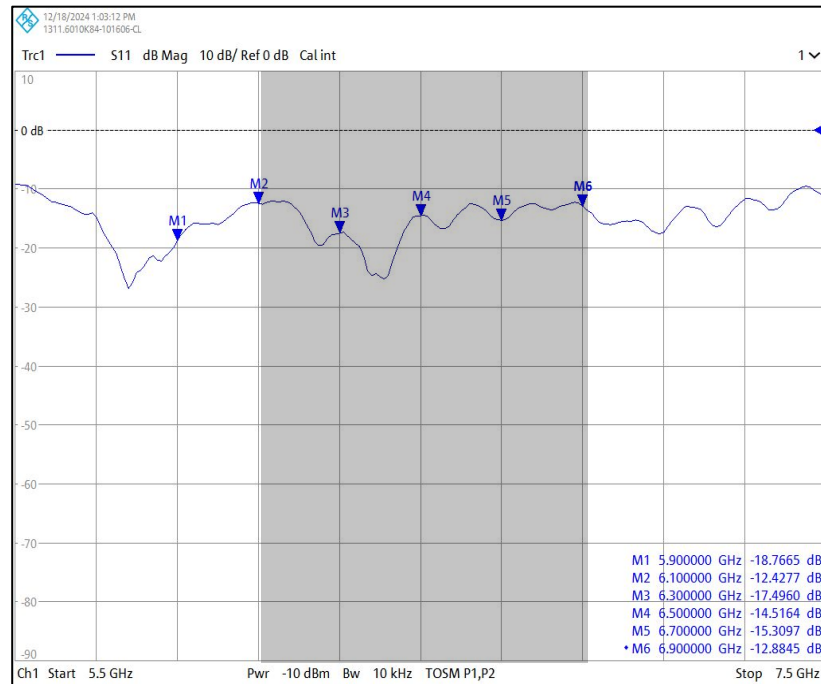


5GHz_Ant2

Testing Results - Return Loss[dB]

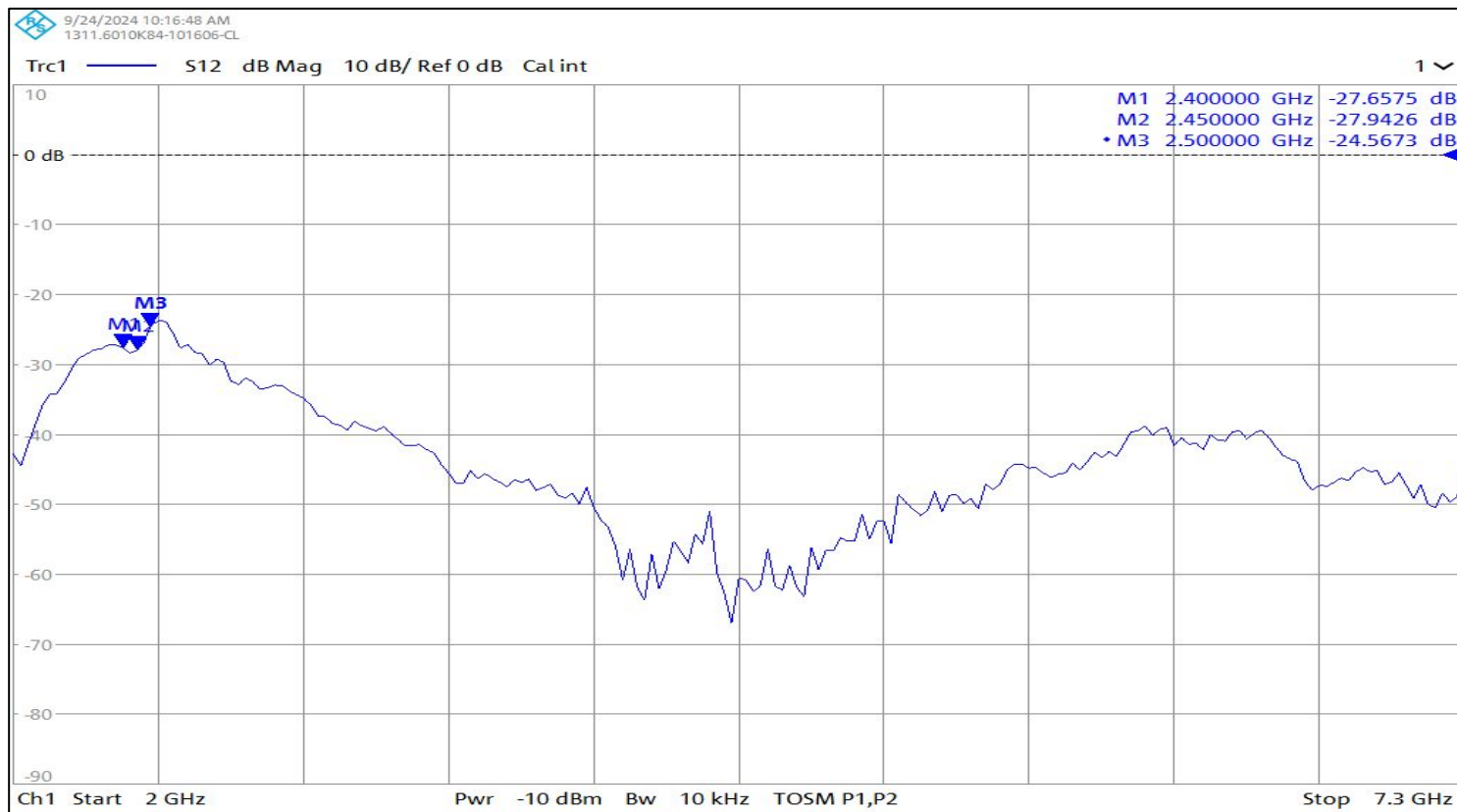


6GHz_Ant1

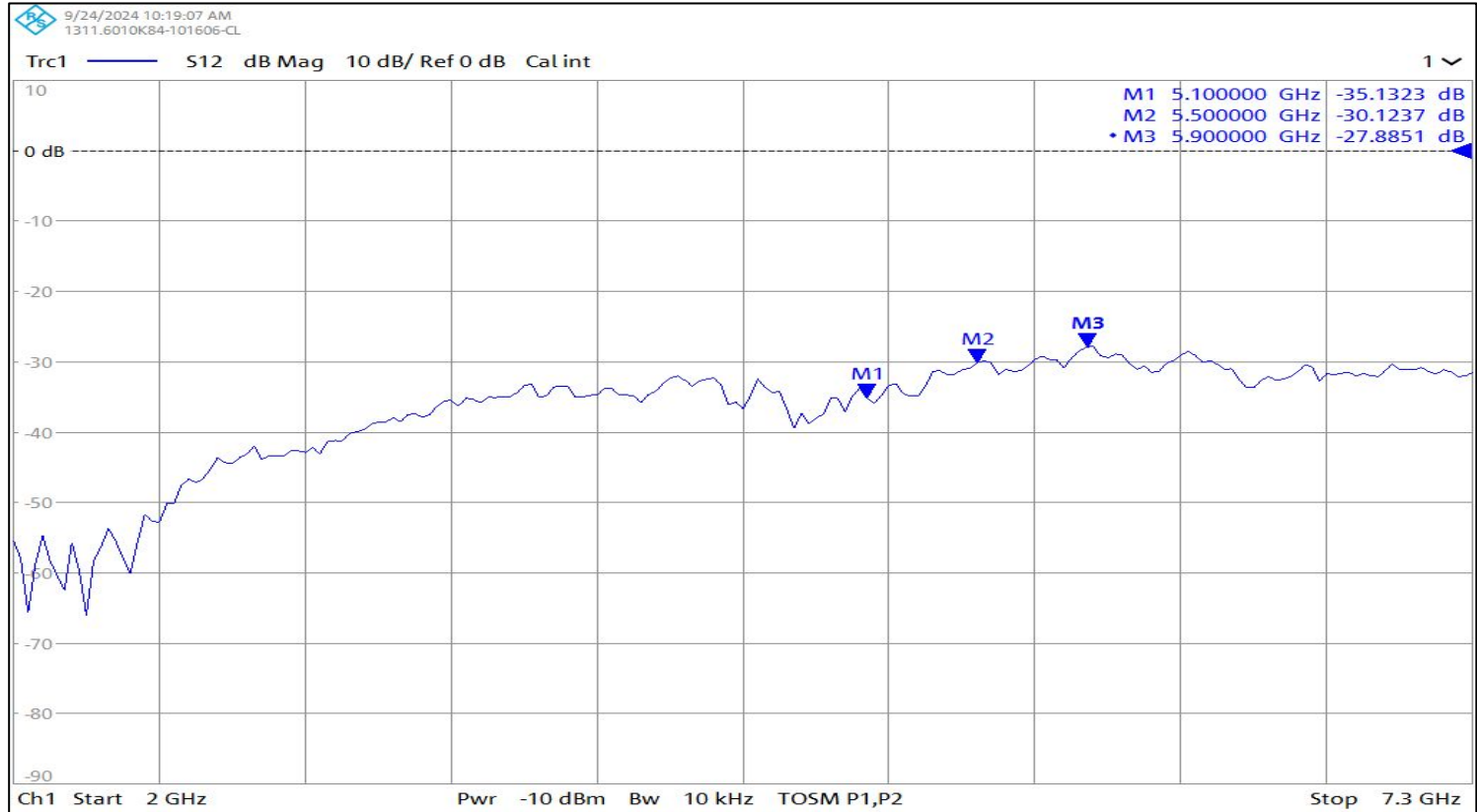


6GHz_Ant2

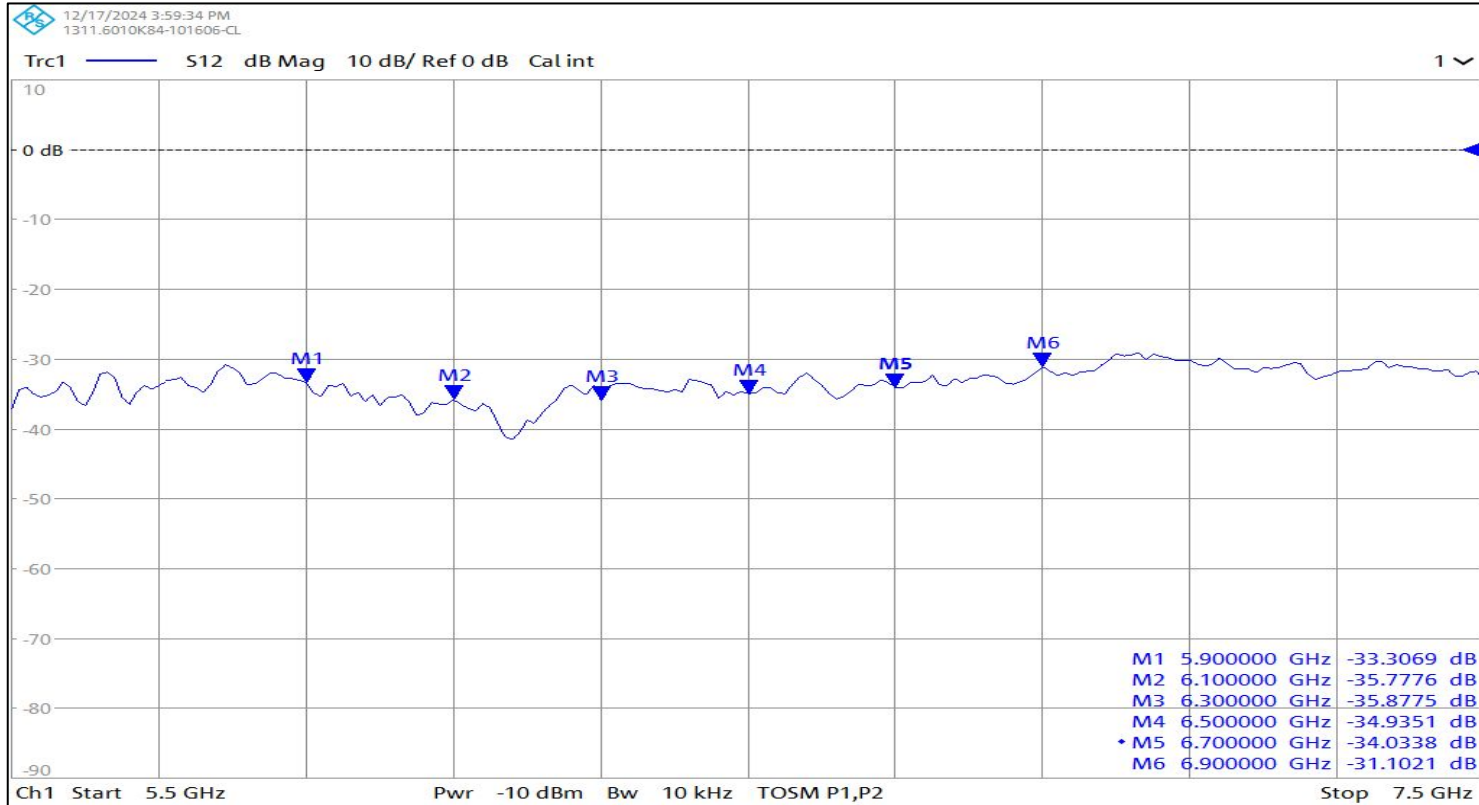
Isolation [dB] - 2.4 GHz (Ant1-Ant2)



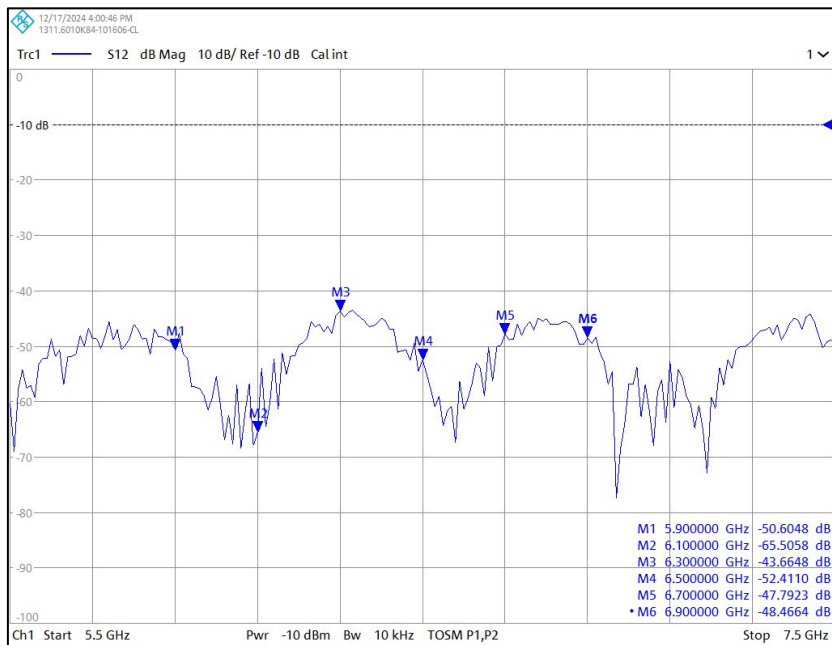
Isolation [dB] - 5 GHz (Ant1-Ant2)



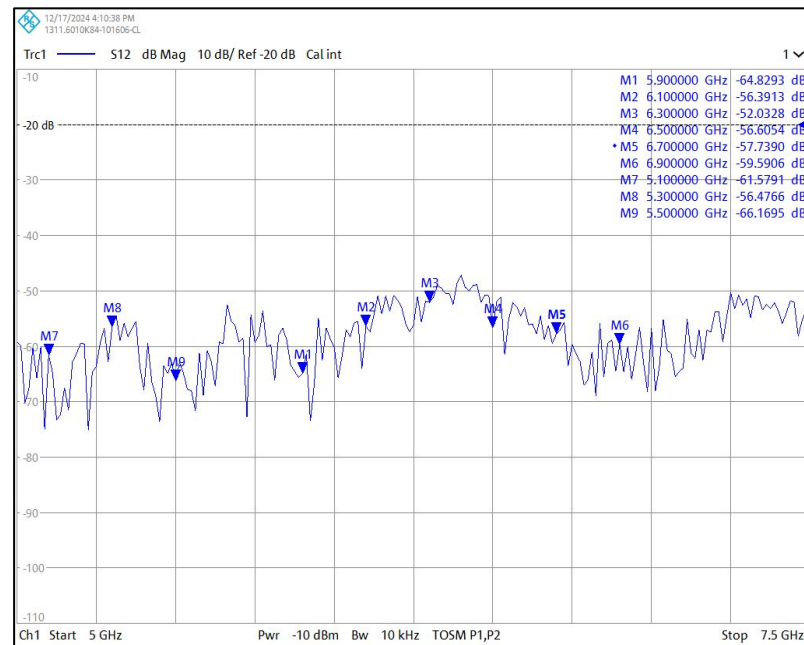
Isolation [dB] - 6 GHz (Ant1-Ant2)



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

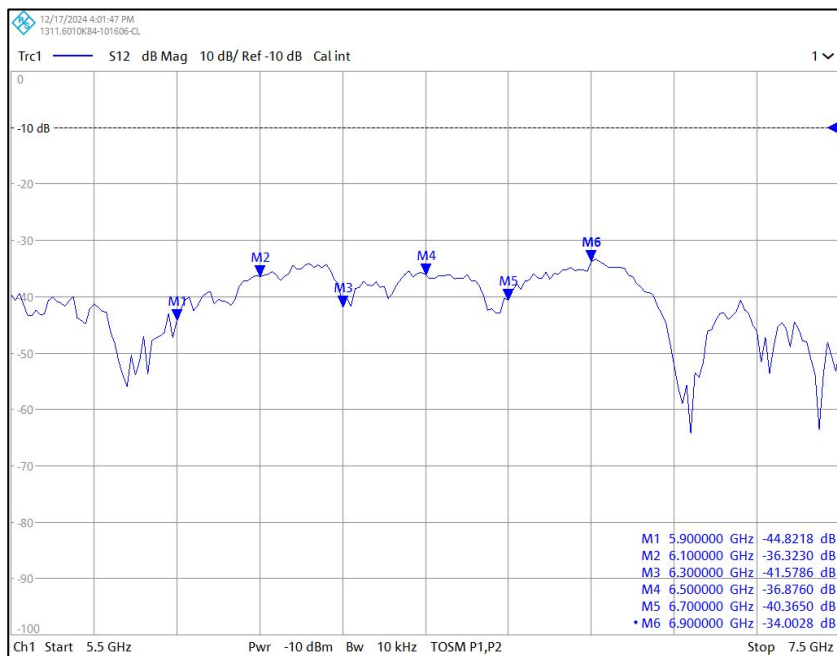


5GHz_Ant1- 6GHz
Ant1

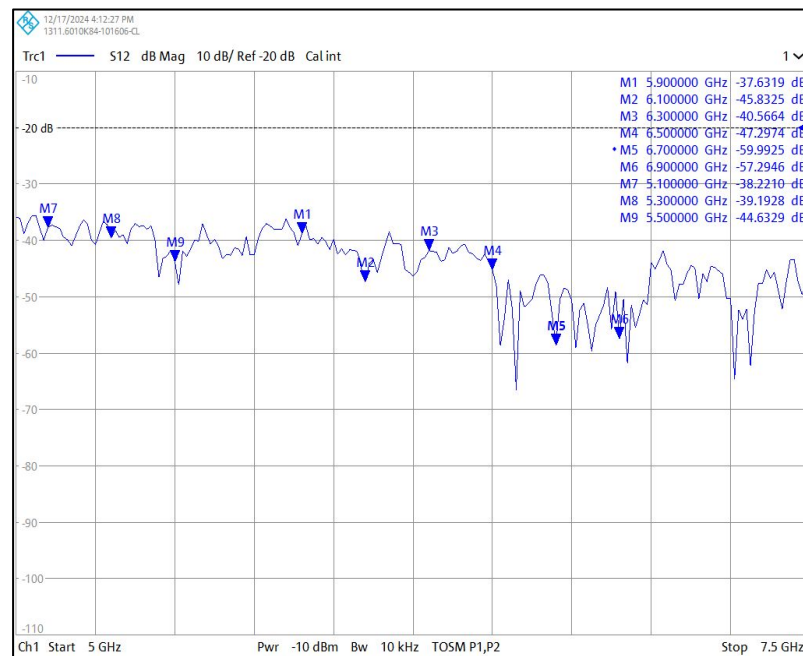


5GHz_Ant1- 6GHz
Ant2

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

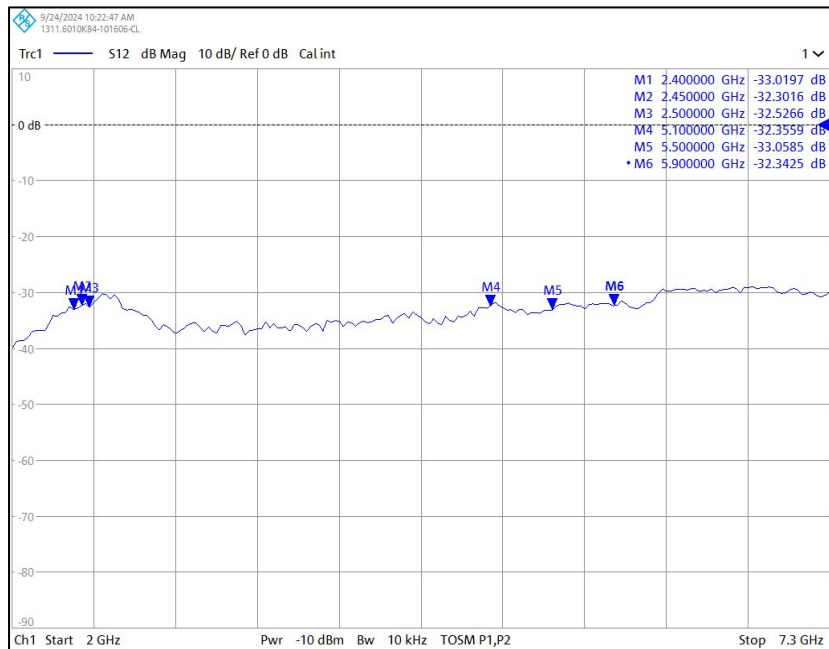


**5GHz_Ant2- 6GHz
Ant1**

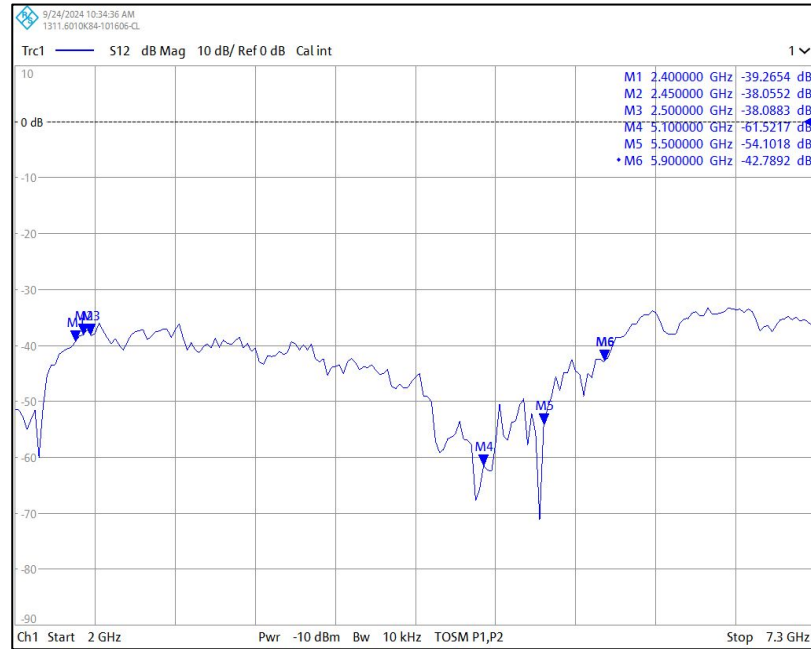


**5GHz_Ant2- 6GHz
Ant2**

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

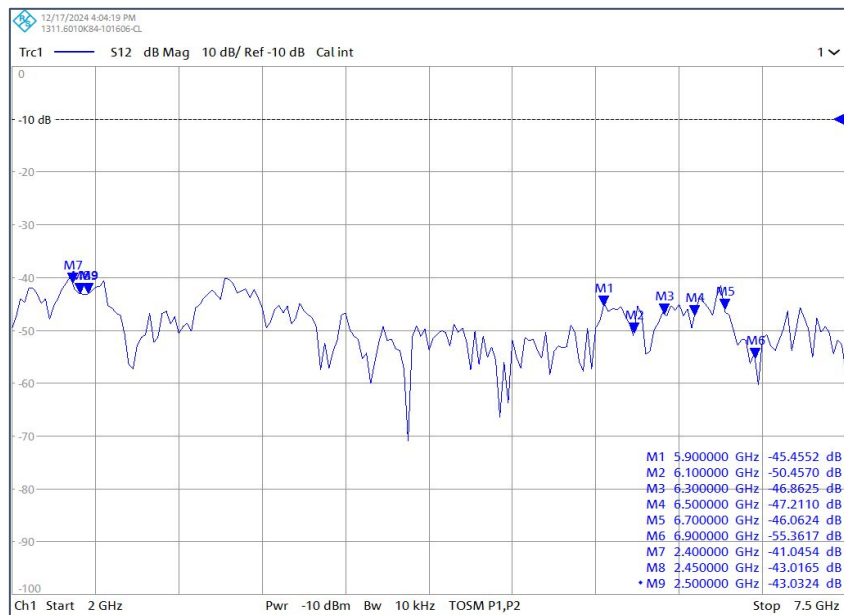


5GHz_Ant1- 2.4GHz Ant1

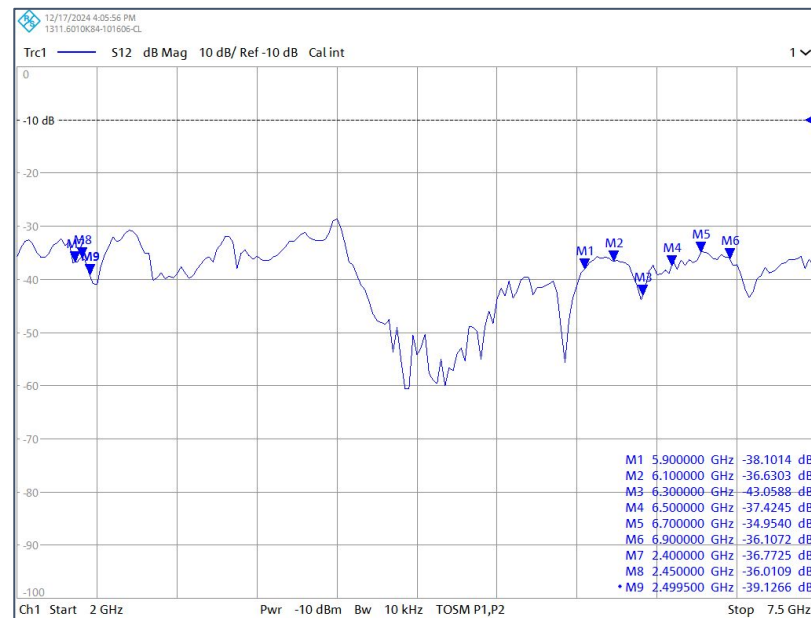


5GHz_Ant1- 2.4GHz Ant2

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

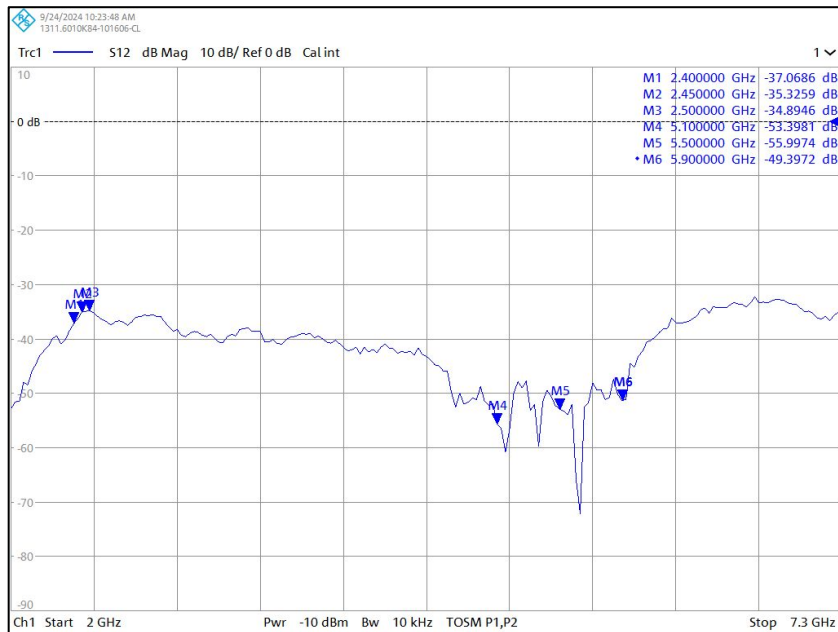


6GHz_Ant1- 2.4GHz Ant1

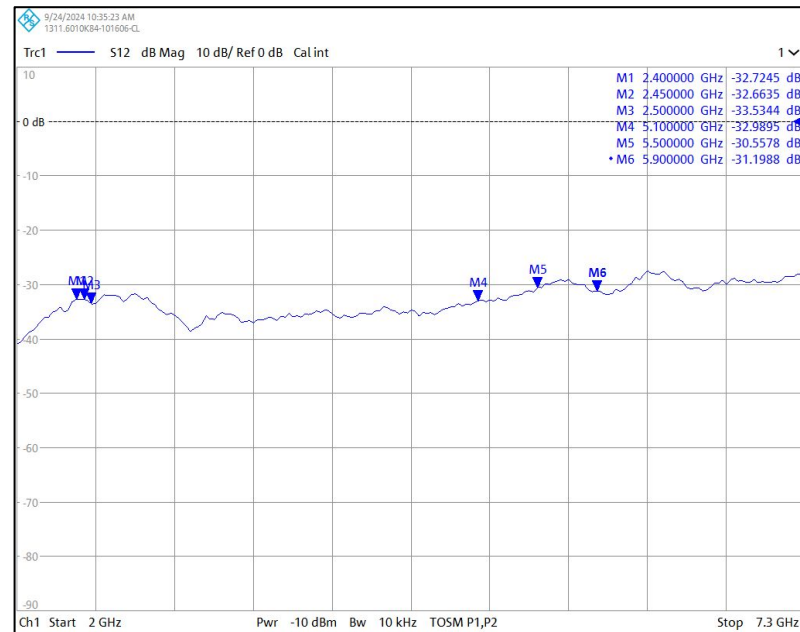


6GHz_Ant1- 2.4GHz Ant2

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

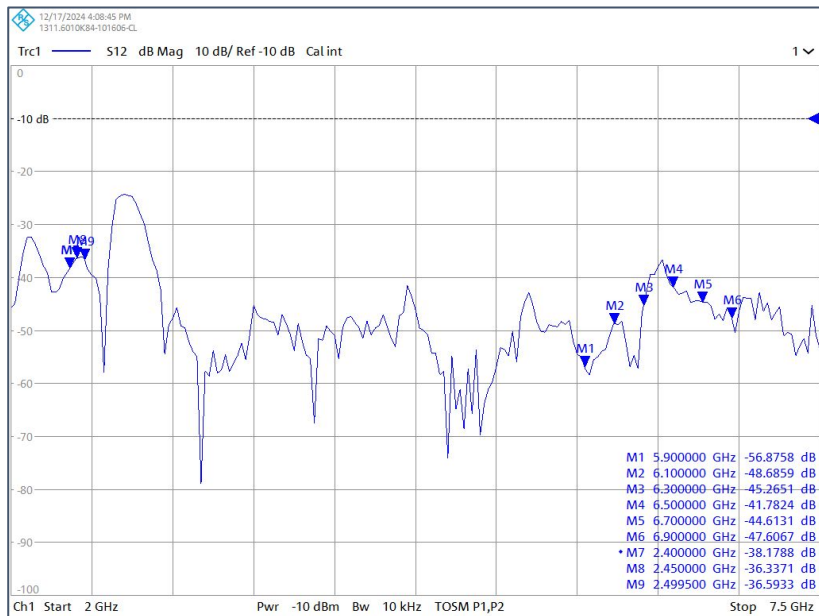


5GHz_Ant2- 2.4GHz Ant1

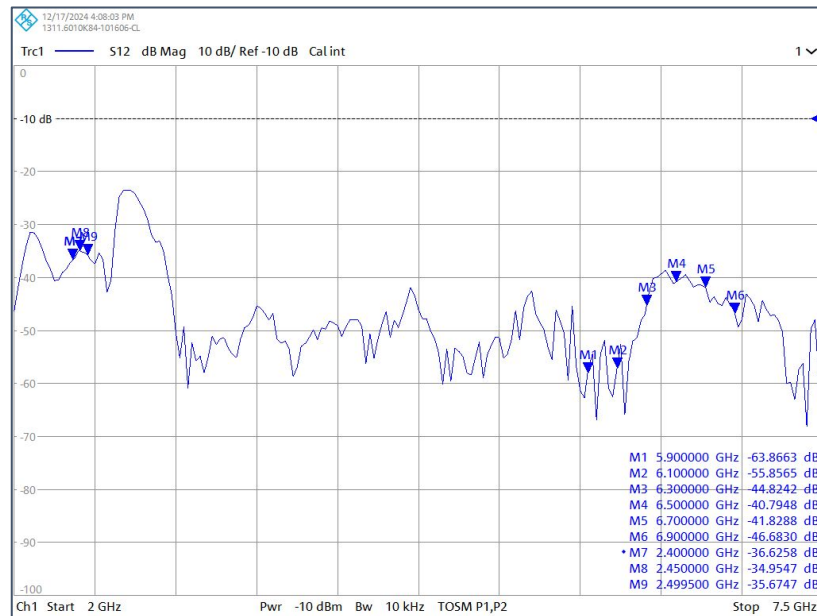


5GHz_Ant2- 2.4GHz Ant2

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



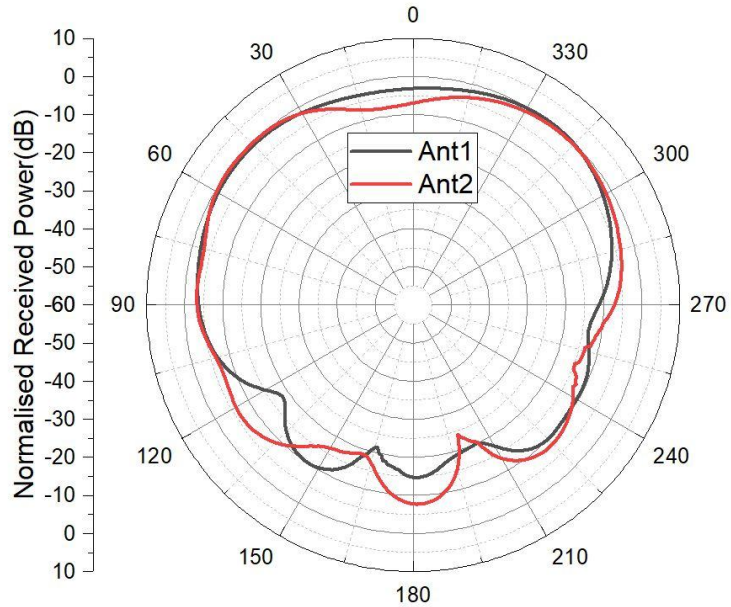
6GHz_Ant2- 2.4GHz Ant1



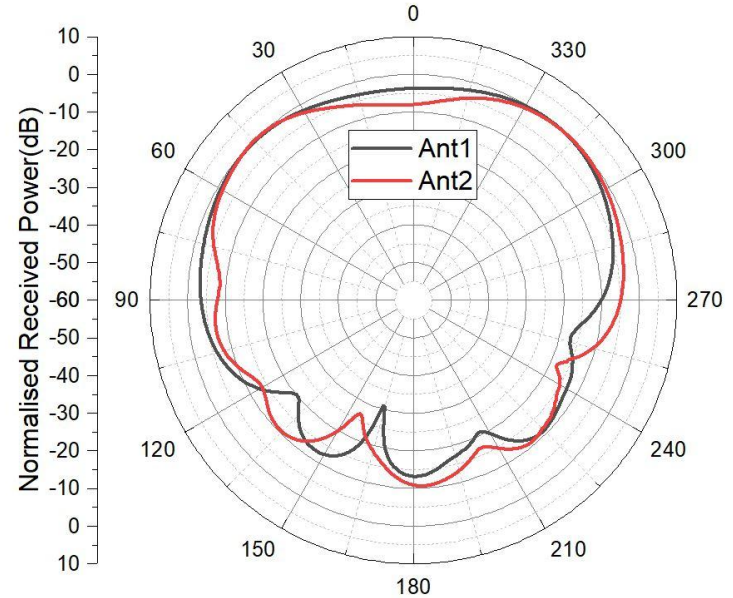
6GHz_Ant2- 2.4GHz Ant2

2.4GHz Antenna

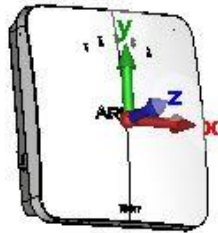
2D Radiation Pattern



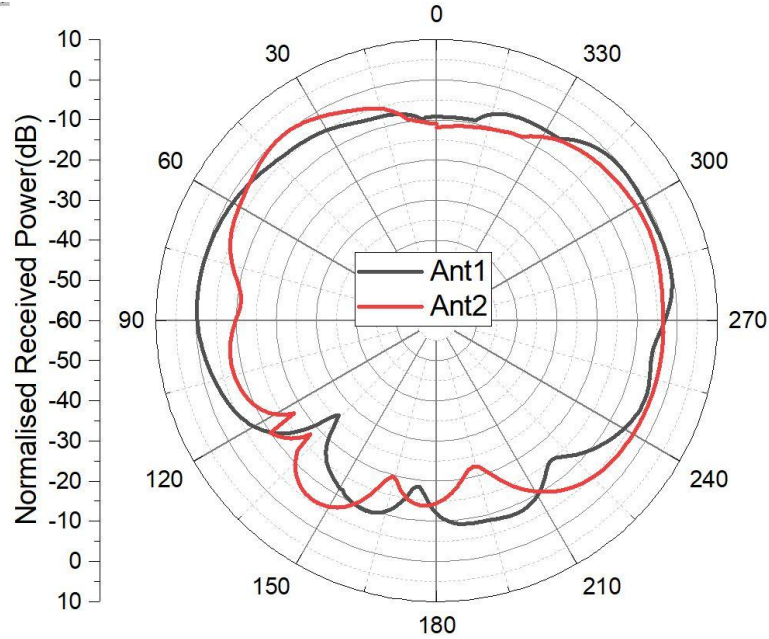
XZ plane 2.45 GHz



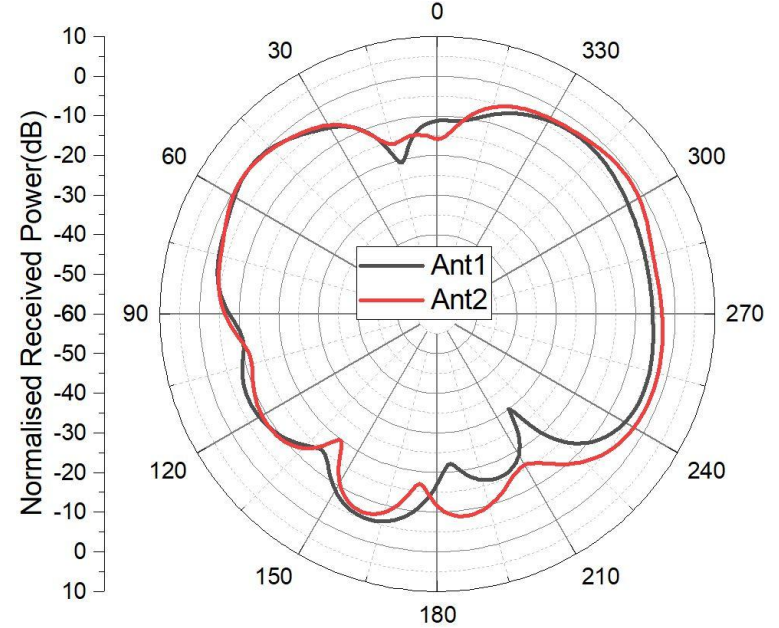
**XZ plane 2.5
GHz**



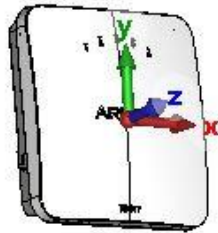
2D Radiation Pattern



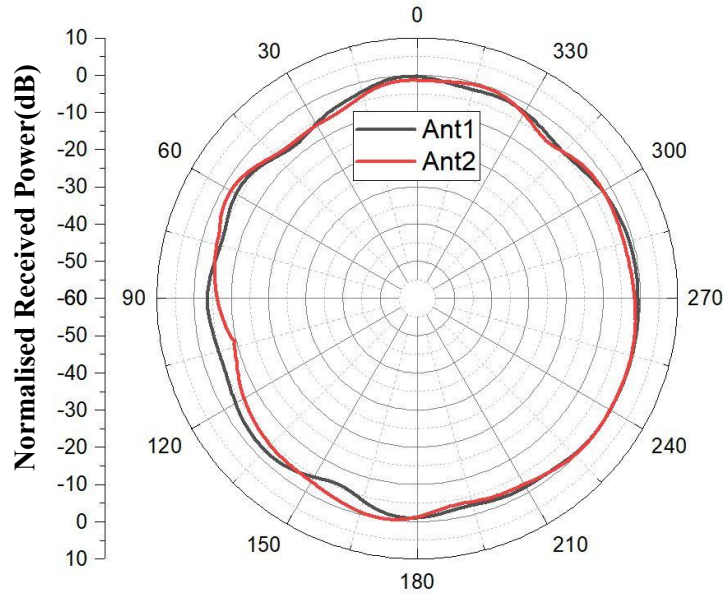
YZ plane 2.45 GHz



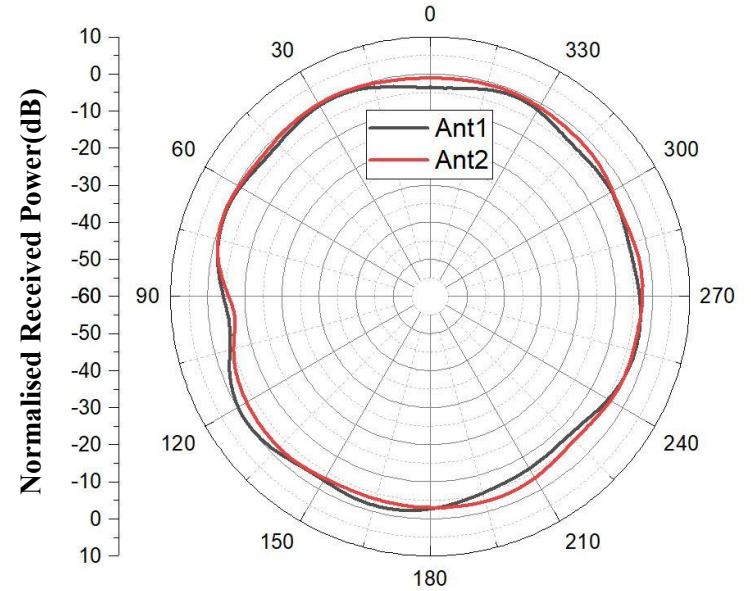
YZ plane 2.5 GHz



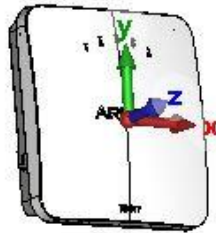
2D Radiation Pattern



XY plane 2.45 GHz (Theta 90)

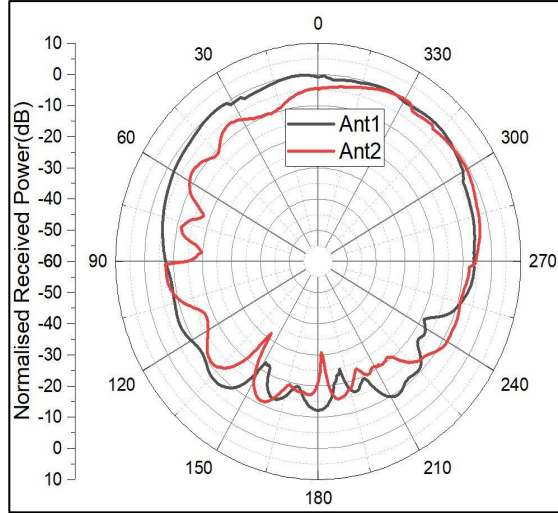


XY plane 2.5 GHz (Theta 90)

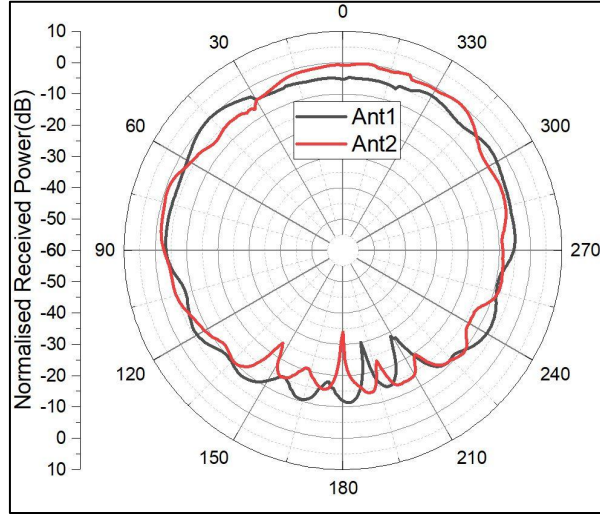


5 GHz Antenna

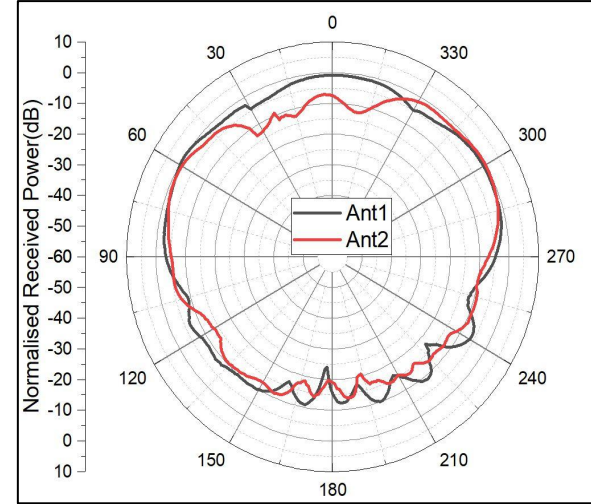
2D Radiation Pattern



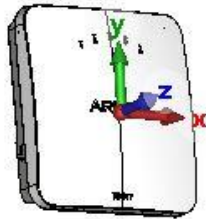
XZ plane 5.1 GHz



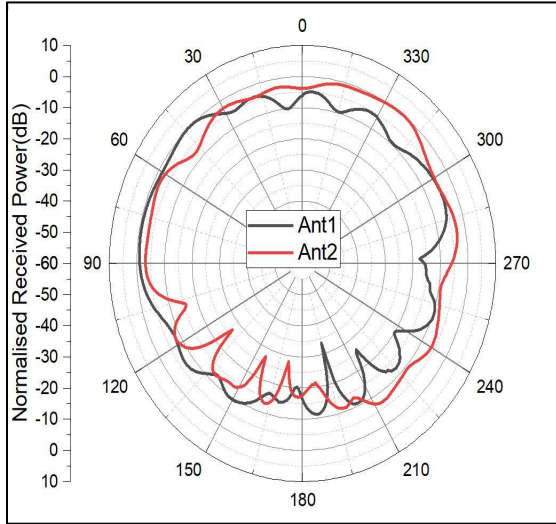
XZ plane 5.5 GHz



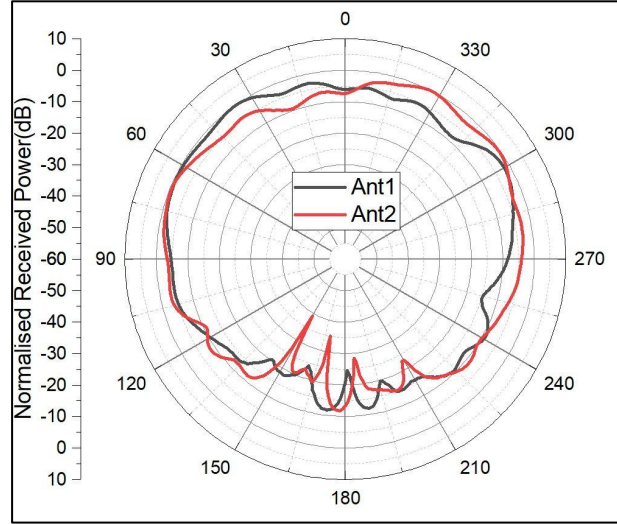
XZ plane 5.9 GHz



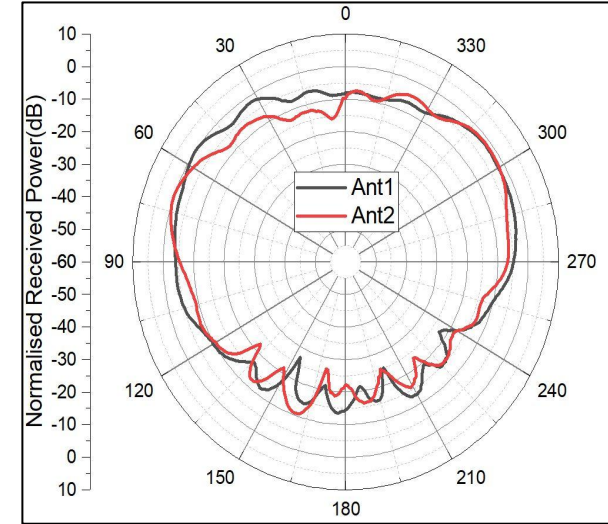
2D Radiation Pattern



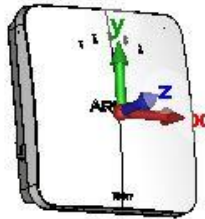
YZ plane 5.1 GHz



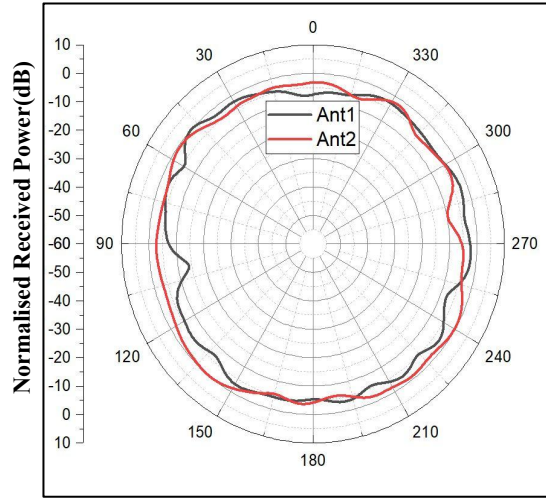
YZ plane 5.5 GHz



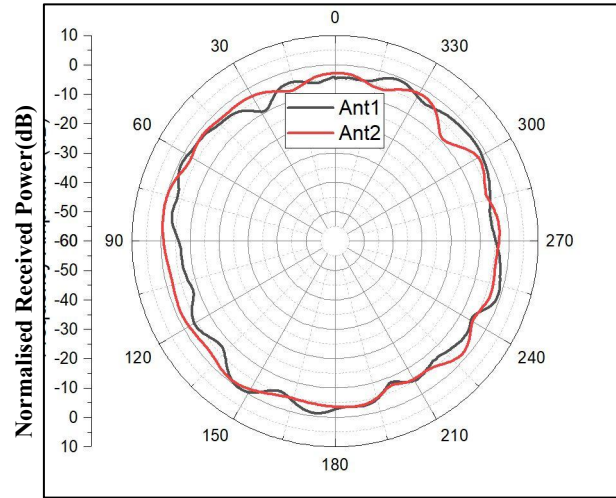
YZ plane 5.9 GHz



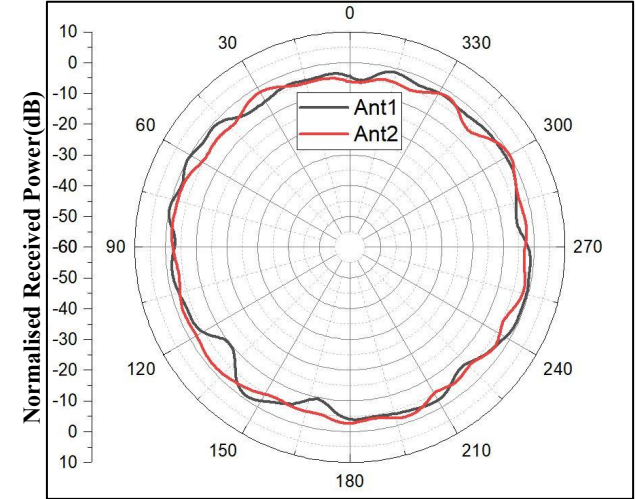
2D Radiation Pattern



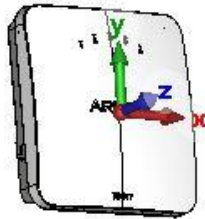
XY plane 5.1 GHz



XY plane 5.5 GHz

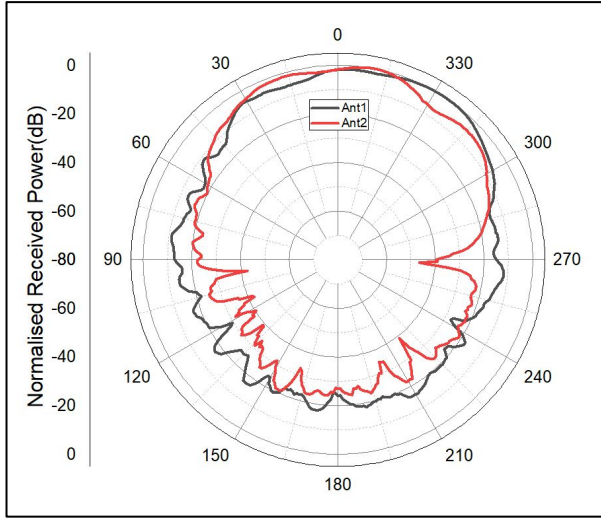


XY plane 5.9 GHz

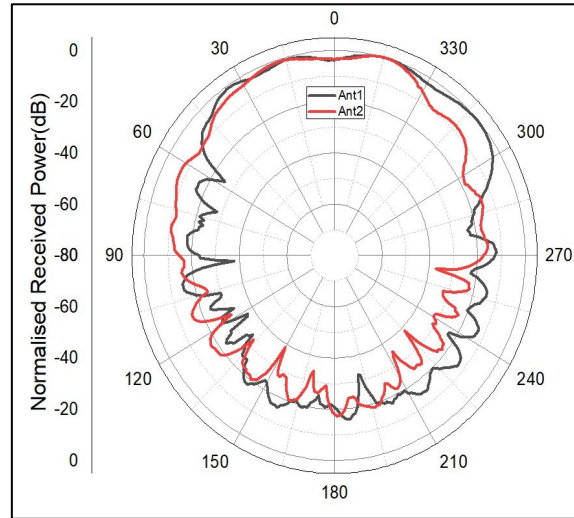


6 GHz Antenna

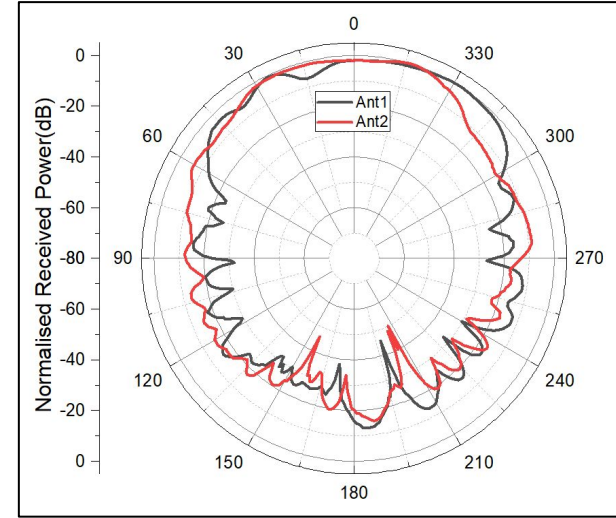
2D Radiation Pattern



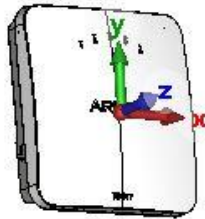
XZ plane 6.1 GHz



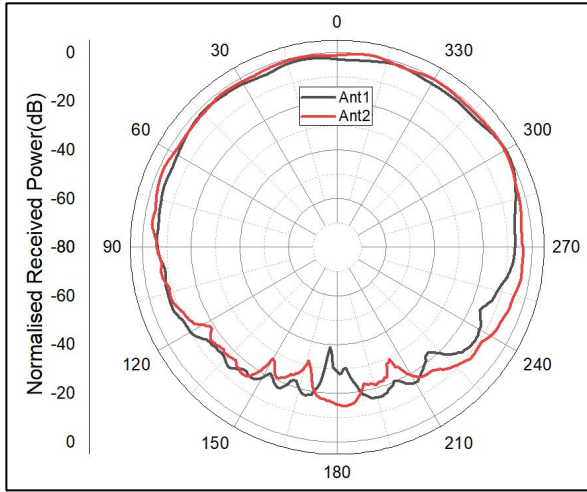
XZ plane 6.5 GHz



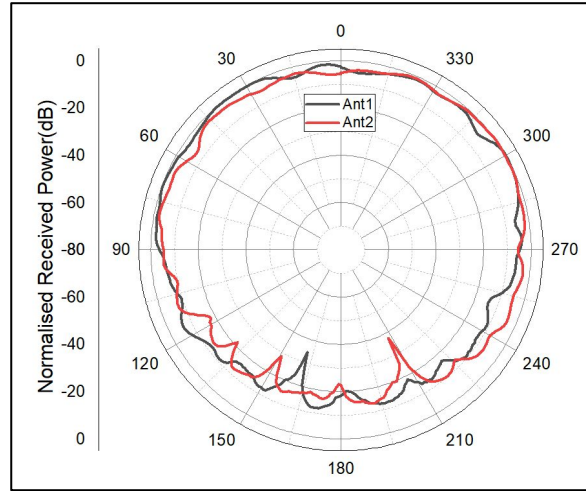
XZ plane 6.9 GHz



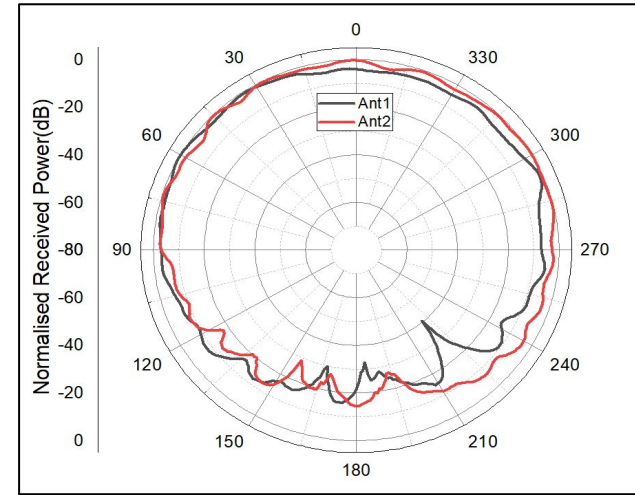
2D Radiation Pattern



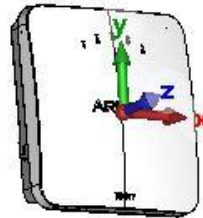
YZ plane 6.1 GHz



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 |

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 |

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 |

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_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_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

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 |

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.



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 |

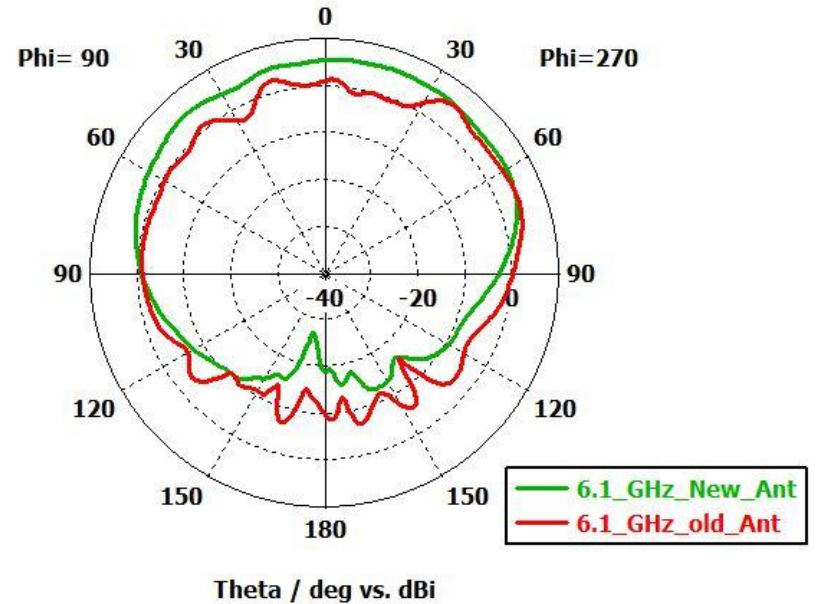
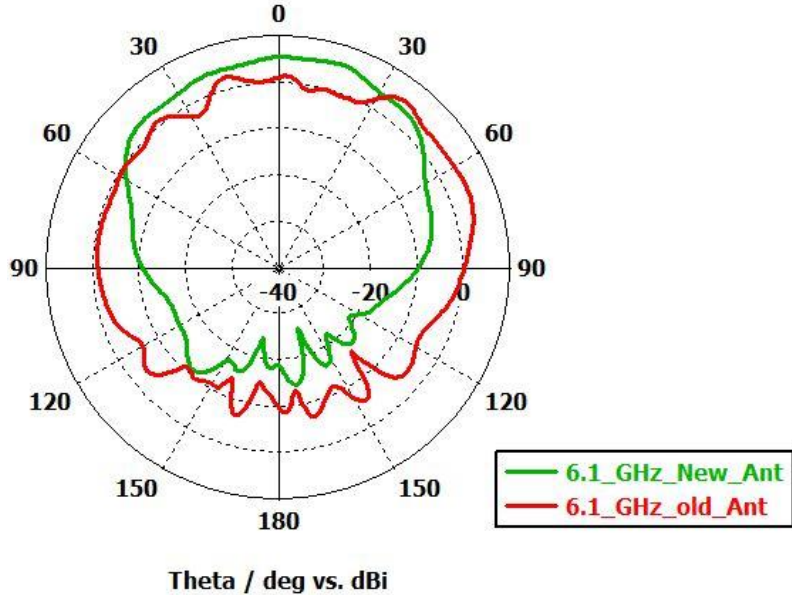
Summarized Characteristics

| <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 patterns 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