JUNIPER AP47E ANTENNA REPORT

Brand: Juniper

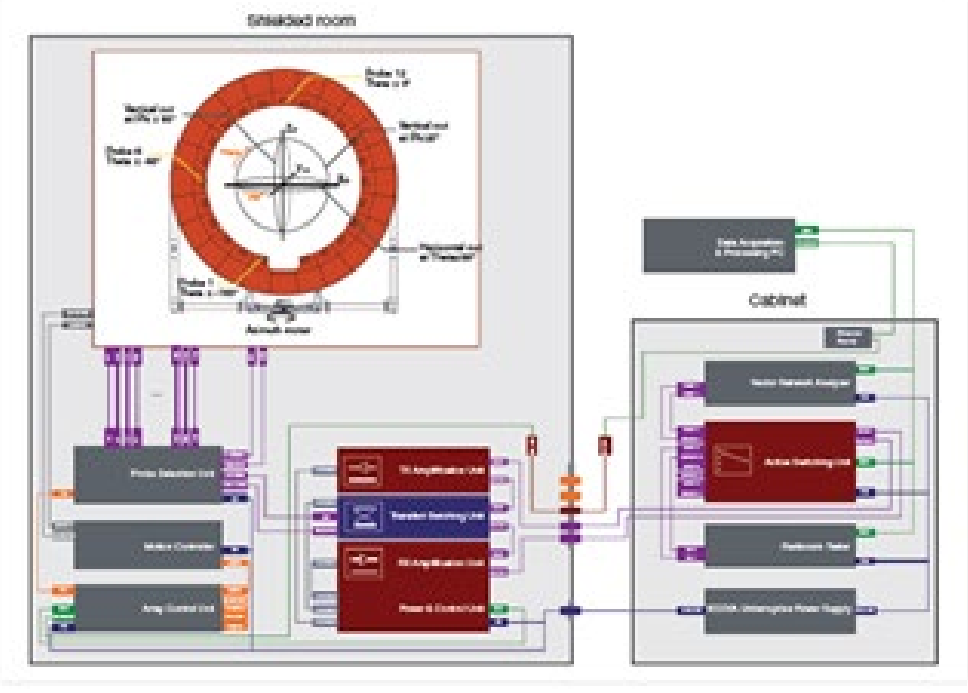
Model: AP47E

Juniper driven by Mist AI

Contents

Chamber Information

- Test Date：20241106
- Test Engineer：Jack Liu
- Measurement System：SATIMO SG24-L
- Software Name：Wave Studio
- Software Version：22.5.6

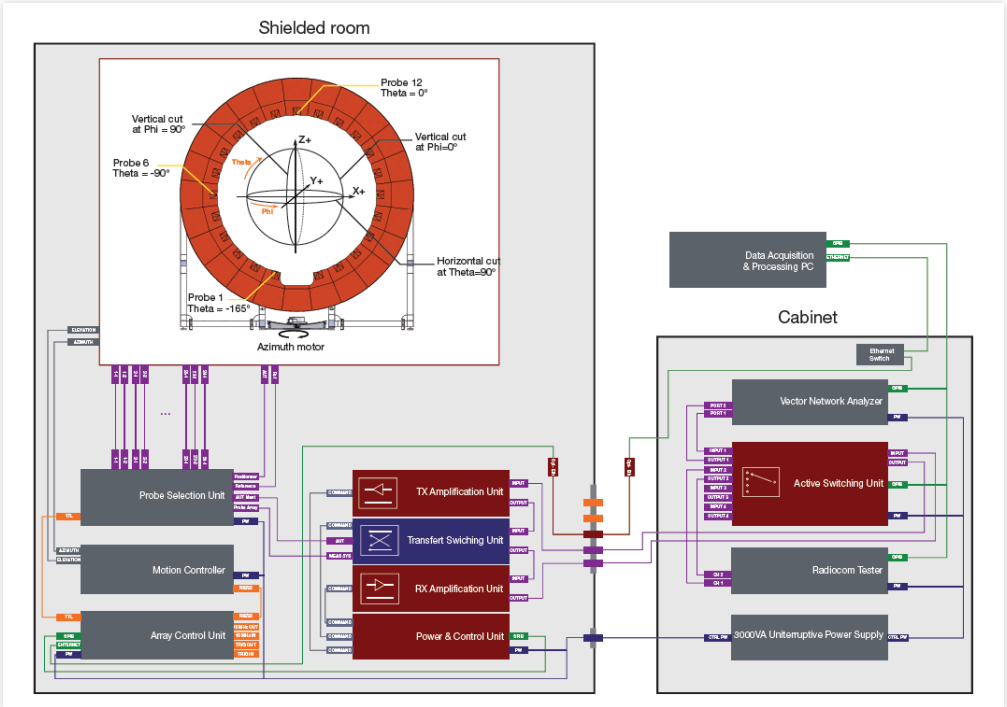


Test Equipment

- Measurement System：SATIMO SG24-L Chamber

- Measurement Setup
  - pattern & gain measurement
    - SATIMO chamber (SG24-L)
    - SATIMO program (wave studio)
    - System overview
  - Test item
    - antenna passive test 400MHz~9GHz

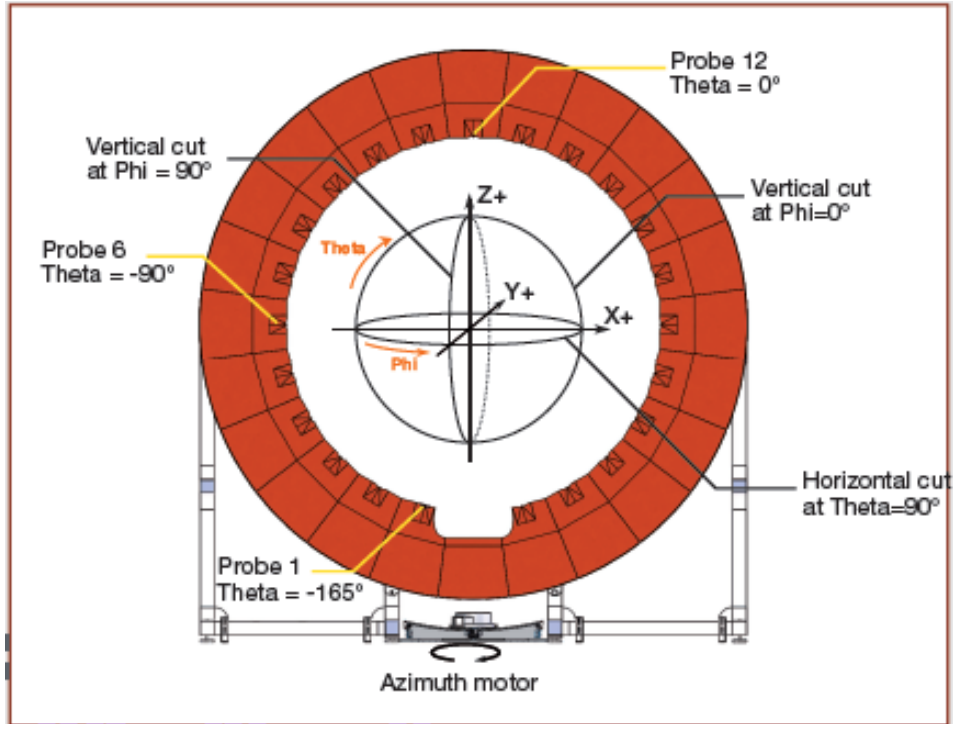
- Calibration Information



Device	Type / Model	Serial #	Manufacture	Cal. Date	Cal. Until
Antenna Measurement System	SG24-L	HKG1669S	MVG-SATIMO	2024-06-05	2025-06-04
Network Analyzer	Keysight E5080B	MY59203136	Keysight	2024-06-05	2025-06-04

Test Procedure

1. Place the device to be tested on the fixture and align it with the center of the chamber.
2. Connect the antenna cable to the RF connector of the chamber.
3. Use the SW to configure parameters (antenna name, frequency points, measurement angles, antenna dimension), and then run the test SW (wave studio).
4. By phi from 0° to 360° and theta from 0° to 180° with a step size of 3 degrees, get the 3D data, including efficiency, peak gain, 2D and 3D radiation patterns.
5. This is far field test for antenna verification.
6. This is passive measurement, which means the device is off and not in any operating mode.



Contents

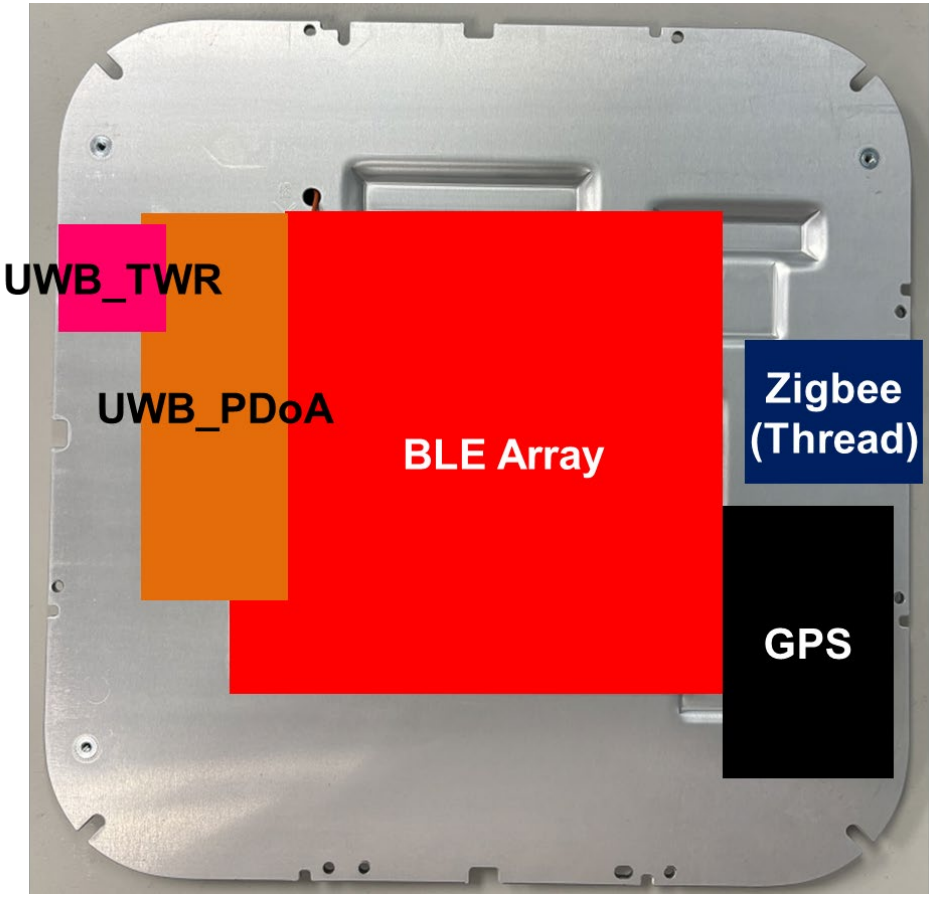
- ***1 x Zigbee(Thread) + 1 x UWB(TWR) + 3 x UWB(PDoA) + 1 x GPS + 1 x BLE Array***
  - *Summary*
  - *Antenna Placement*
  - *Zigbee (Thread)*
  - *GPS*
  - *UWB TWR*
  - *UWB PDoA*
  - *Isolation among Radios*
  - *BLE Array Antennas*

Summary

The summary of antenna performance are shown in below.

- Radiation efficiency
  - ~71% for 2.4GHz Zigbee(Thread) antenna [Zigbee(Thread)]
  - ~54% for L1, ~60% for L5 GPS antenna [GPS]
  - ~61% for Ch9 UWB TWR antenna [UWB-TWR] ;
  - ~19% for Ch9 UWB PDoA antennas [UWB2, UWB3, UWB4]
  - ~15% for 2.4GHz BLE array [Beam1~Beam8]; ~25% for 2.4GHz BLE slot_directional antenna [Beam9]
  - ~21% for 2.4GHz BLE array [Omni]
- Peak gain
  - 4.1 dBi for 2.4GHz Zigbee(Thread) antenna [Zigbee(Thread)]
  - 1.7 dBi for L1, 3.3 dBi for L5 GPS antenna [GPS]
  - 4.7 dBi for Ch9 UWB TWR antenna [UWB-TWR] ;
  - 2.1 dBi for Ch9 UWB PDoA antennas [UWB2, UWB3, UWB4]
  - 4.0 dBi for 2.4GHz BLE array [Beam1~Beam8]; 2.6 dBi for 2.4GHz BLE slot_directional antenna [Beam9]
  - 1.0 dBi for 2.4GHz BLE array [Omni]

Antenna Placement



Radio	Antenna Type
GPS	PIFA
UWB-TWR	Patch
UWB-PDoA	Patch
Zigbee(Thread)	PIFA
BLE [Beam1~Beam8/Omni]	PIFA
BLE [Beam9]	Slot

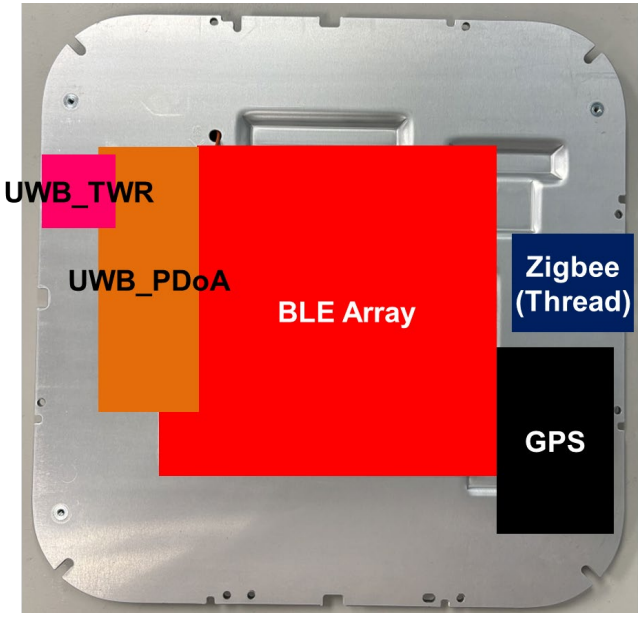
Antenna Plate: 246x246mm

UWB_TWR	Peak Gain	Position of Peak Gain (θ, φ)
TWR	4.7 dBi	θ = 63° , φ = 15°

Zigbee(Thread)	Peak Gain	Position of Peak Gain (θ, φ)
Zigbee(Thread)	4.1 dBi	θ = 54° , φ = 93°

BLE Array	Peak Gain	Position of Peak Gain (θ, φ)
BLE Array (Beam8)	4.0 dBi	θ = 53° , φ = 135°

Zigbee(Thread)

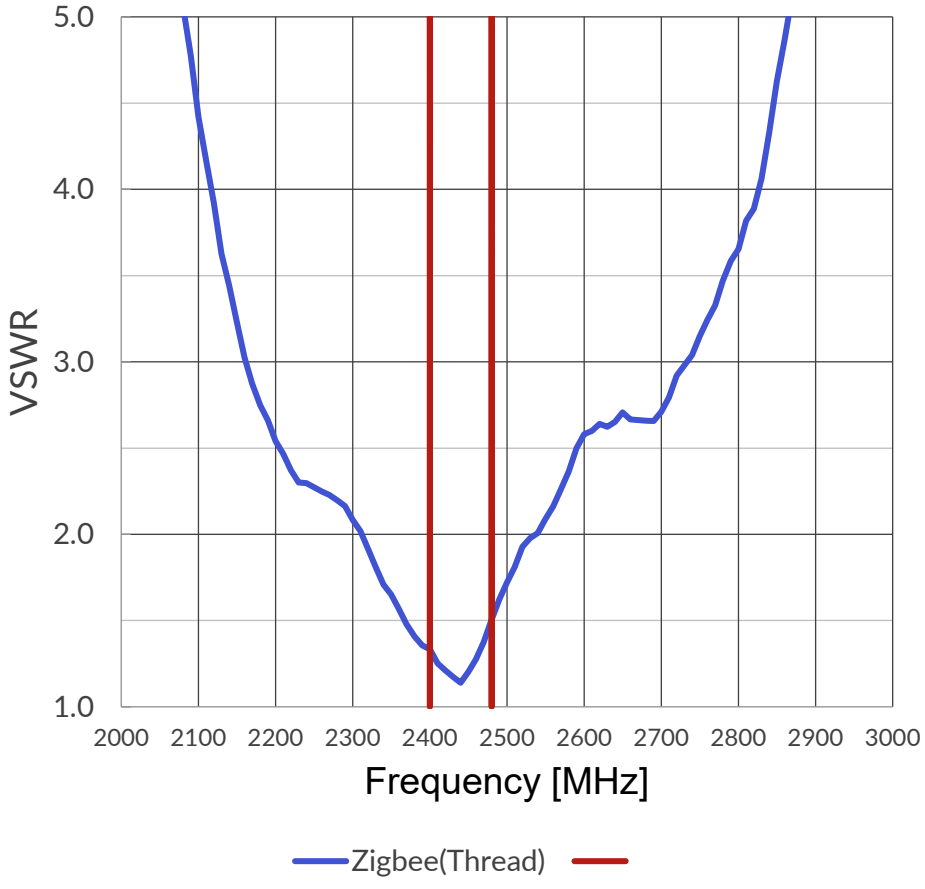


- **Maximum VSWR**
  - 1.5:1 on 2.4GHz
- **Average Efficiency**
  - ~71% on 2.4GHz
- **Peak Gain**
  - 4.1dBi on 2.4GHz

- **Cable Length**

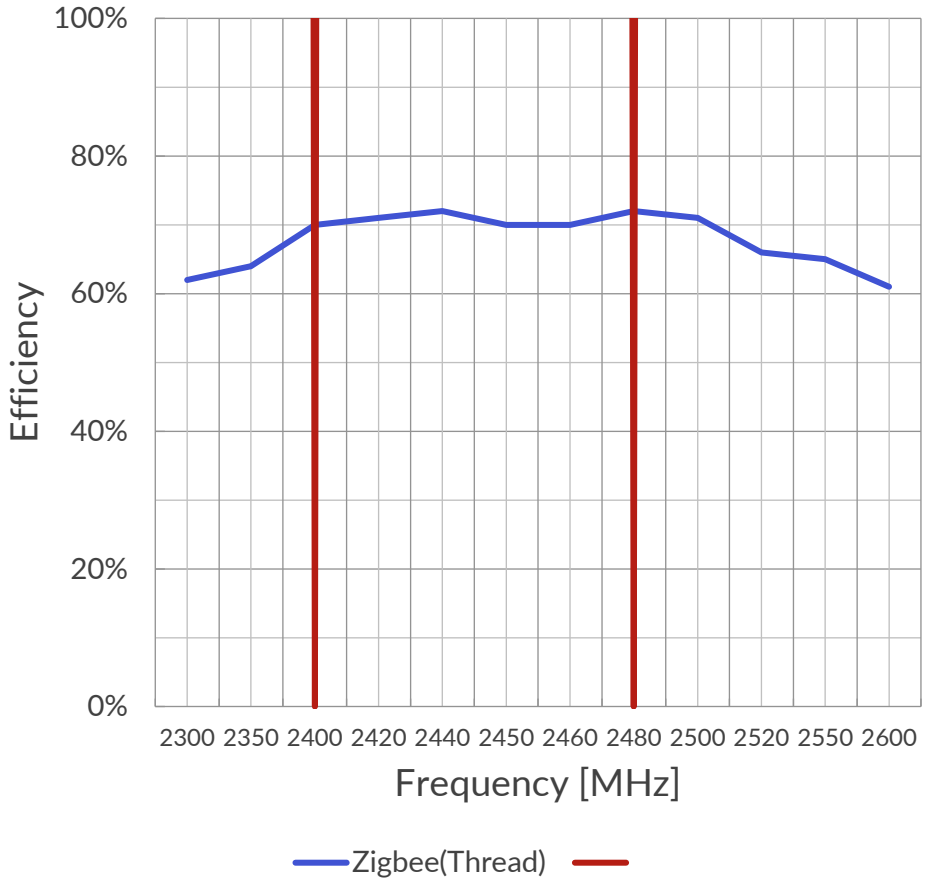
  Zigbee(Thread)：232mm

VSWR Zigbee(Thread)



2.4GHz	Max	Mean	Min
Zigbee(Thread)	1.5	1.3	1.1

Efficiency Zigbee(Thread)

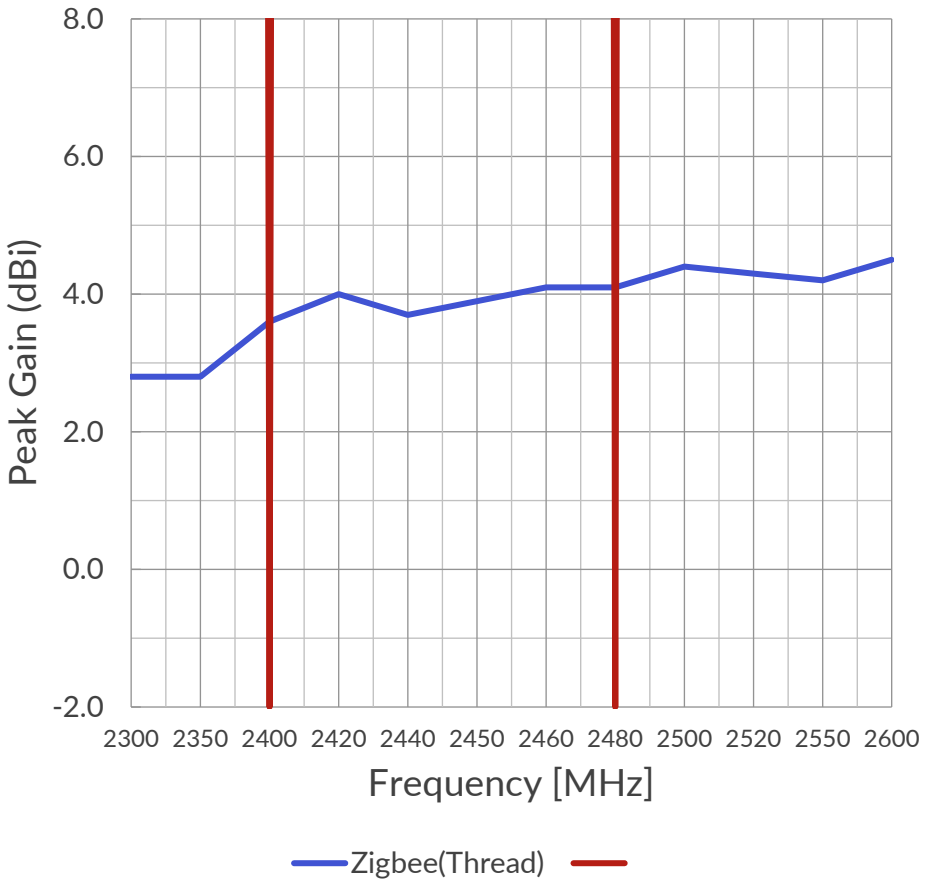


2.4GHz	Max	Mean	Min
Zigbee(Thread)	72 %	71 %	70 %

- **Cable Length**

  Zigbee(Thread)：232mm

Peak Gain Zigbee(Thread)



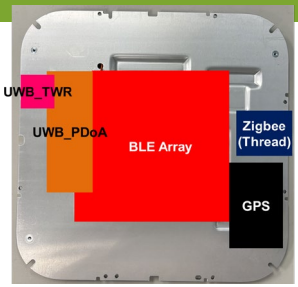
2.4GHz	Max	Mean	Min
Zigbee(Thread)	4.1 dBi	3.9 dBi	3.6 dBi

- **Cable Length**

  Zigbee(Thread)：232mm

Realized Gain Pattern

Zigbee(Thread) @2440MHz for Gtotal



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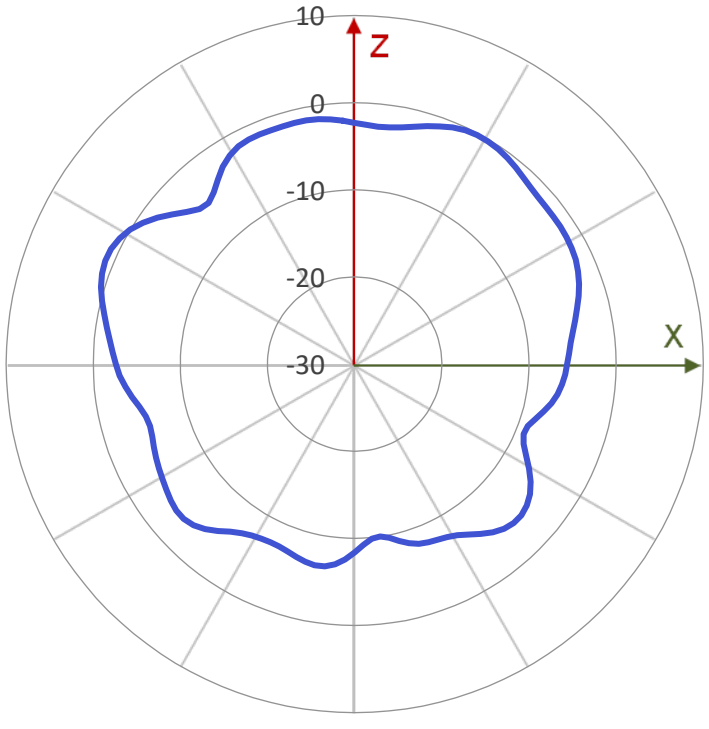

Zigbee(Thread)

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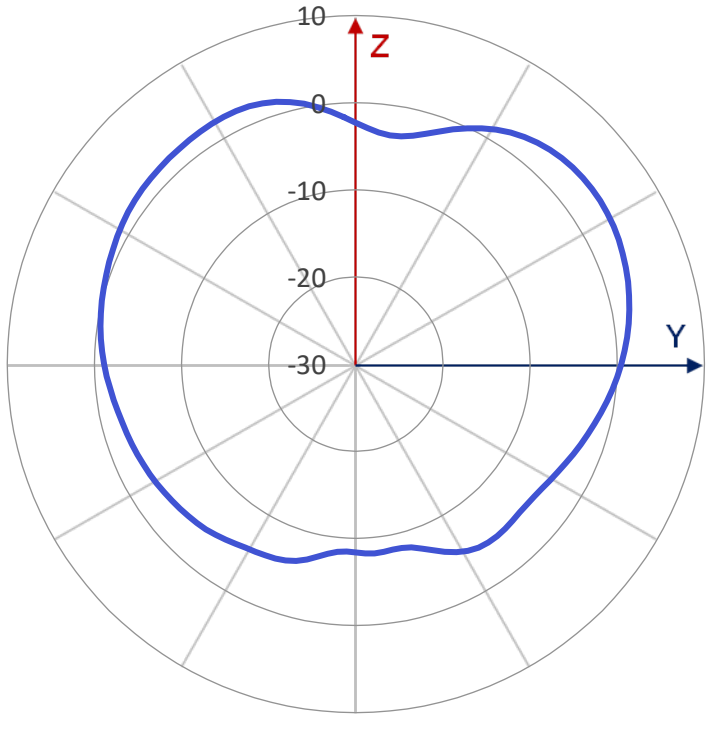

Zigbee(Thread)

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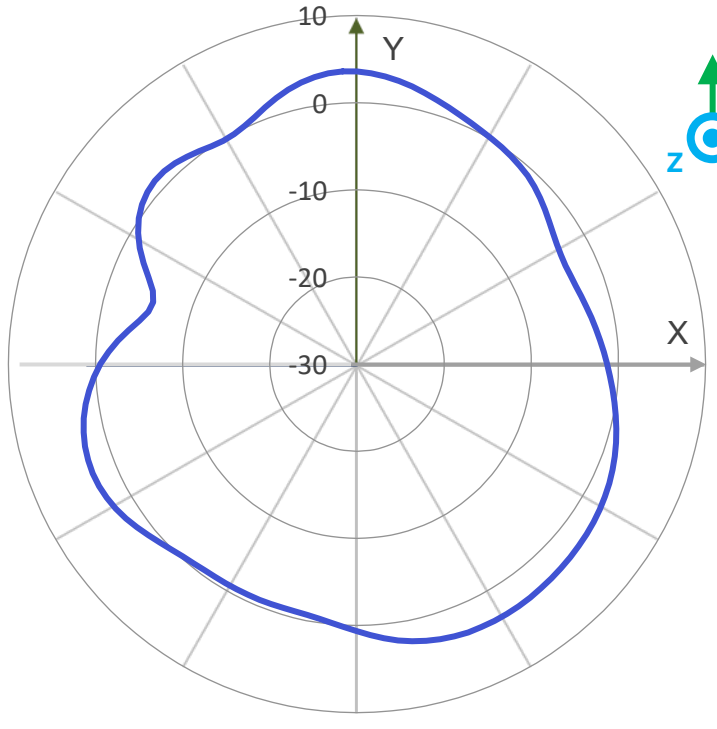
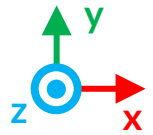
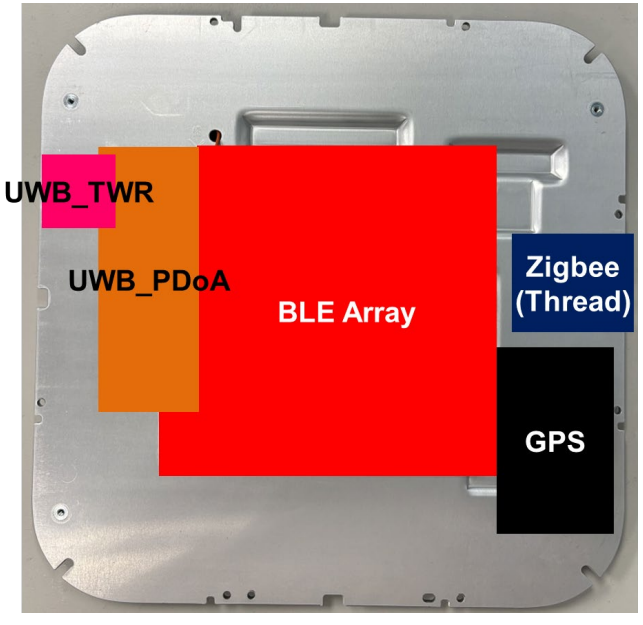




Zigbee

GPS

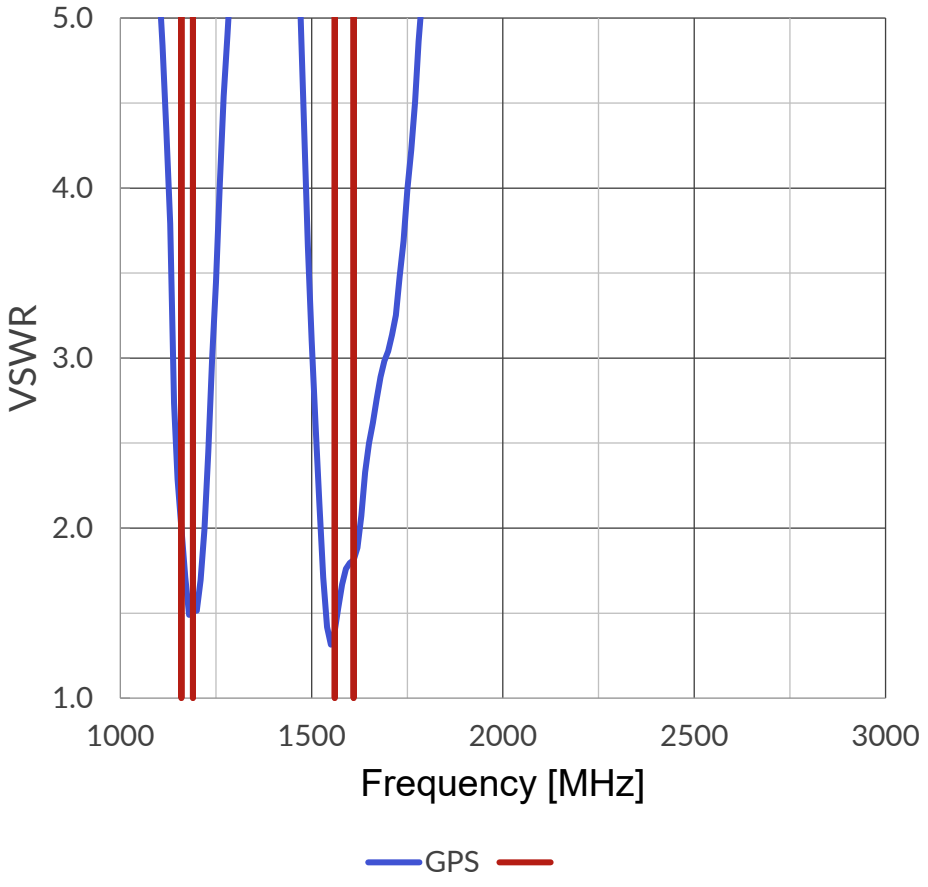


- **Maximum VSWR**
  - 1.8:1 on L1 / 2.0:1 on L5
- **Average Efficiency**
  - ~54% on L1 / ~60% on L5
- **Peak Gain**
  - 1.7dBi on L1 / 3.3dBi on L5

- **Cable Length**

  GPS：314mm

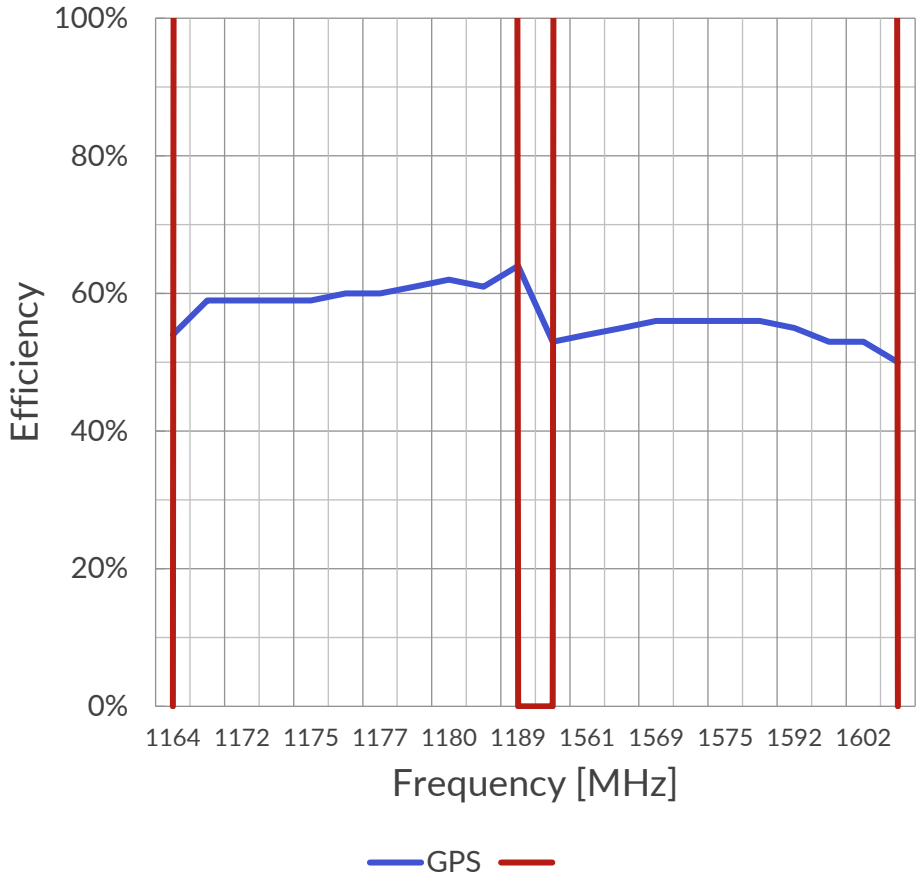
VSWR GPS



L1	Max	Mean	Min
GPS	1.8	1.7	1.4

L5	Max	Mean	Min
GPS	2.0	1.9	1.5

Efficiency GPS



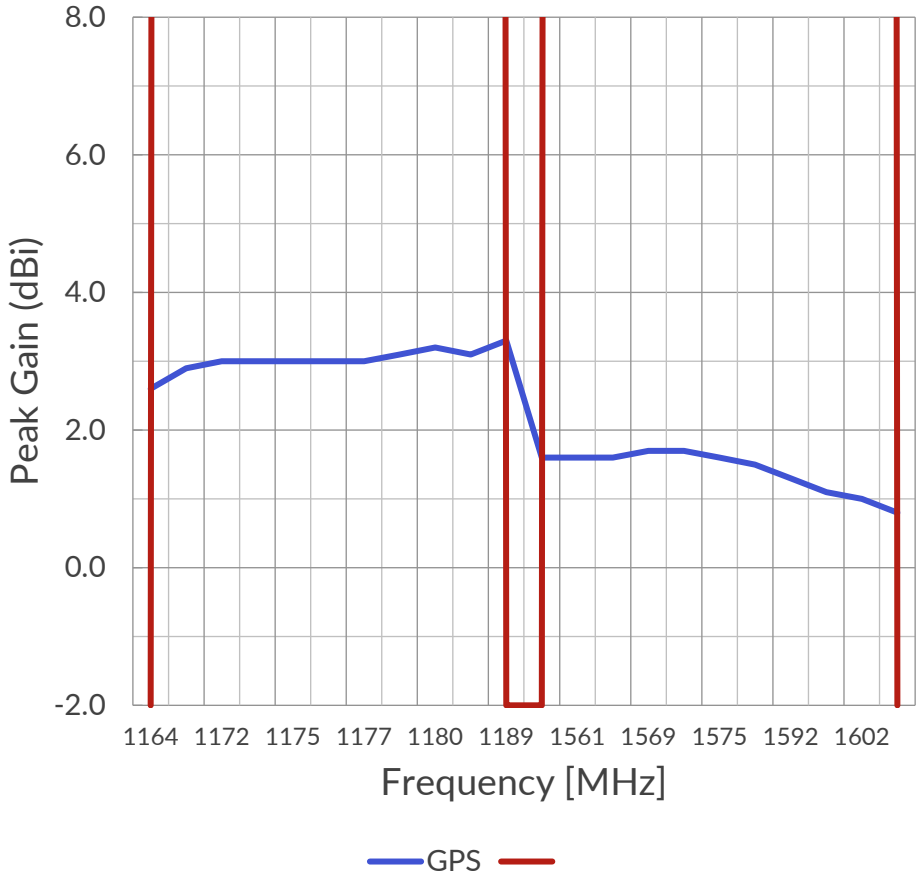
L1	Max	Mean	Min
GPS	56 %	54 %	50 %

L5	Max	Mean	Min
GPS	64 %	60%	54 %

- **Cable Length**

  GPS：314mm

Peak Gain GPS



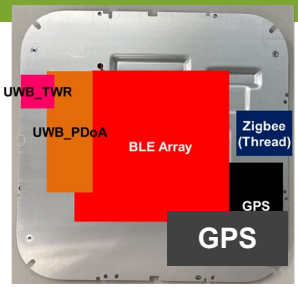
L1	Max	Mean	Min
GPS	1.7 dBi	1.4 dBi	0.8 dBi

L5	Max	Mean	Min
GPS	3.3 dBi	3.0 dBi	2.6 dBi

- **Cable Length**

  GPS：314mm

Realized Gain Pattern GPS @1575MHz for Gtotal



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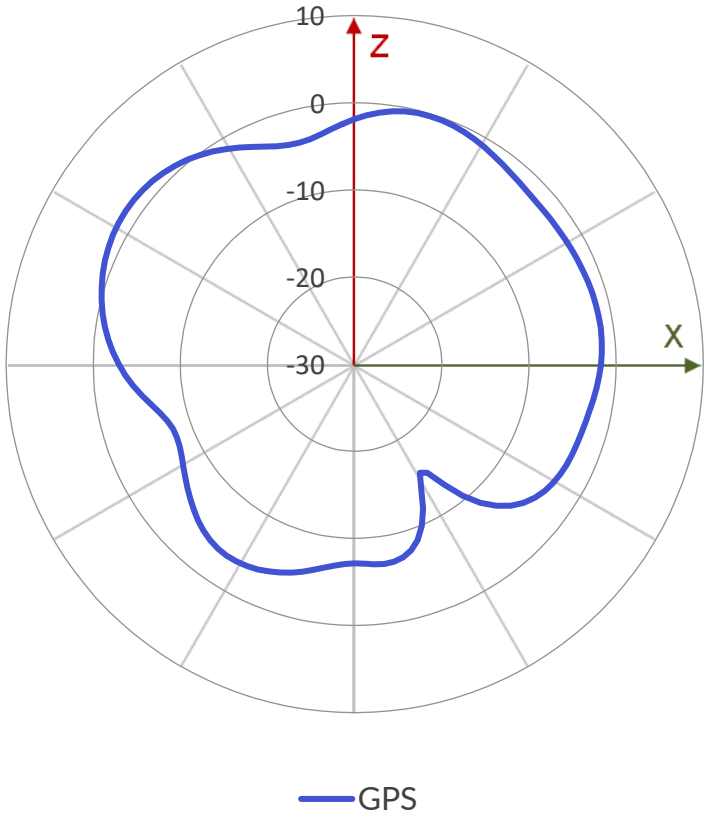

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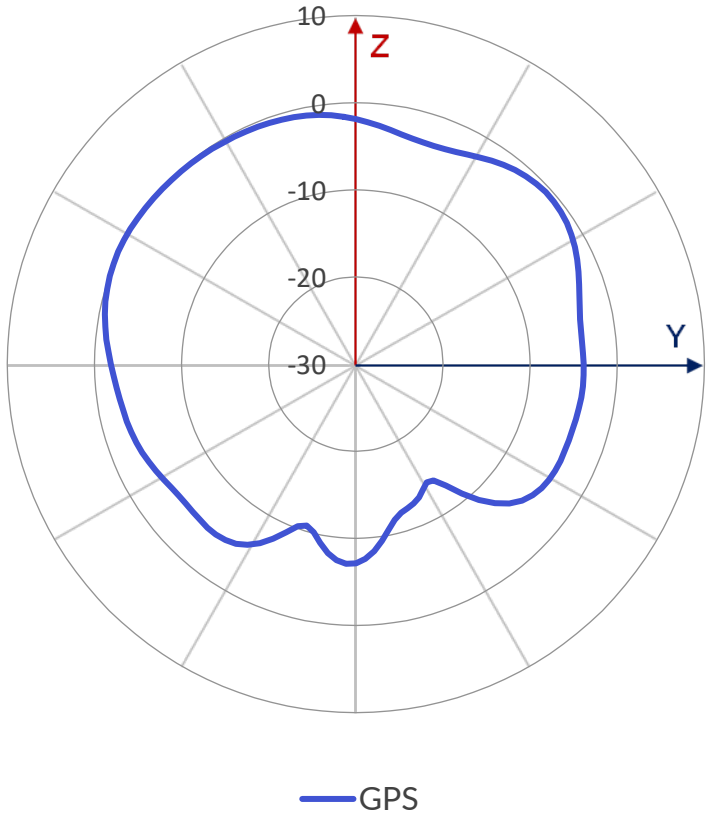

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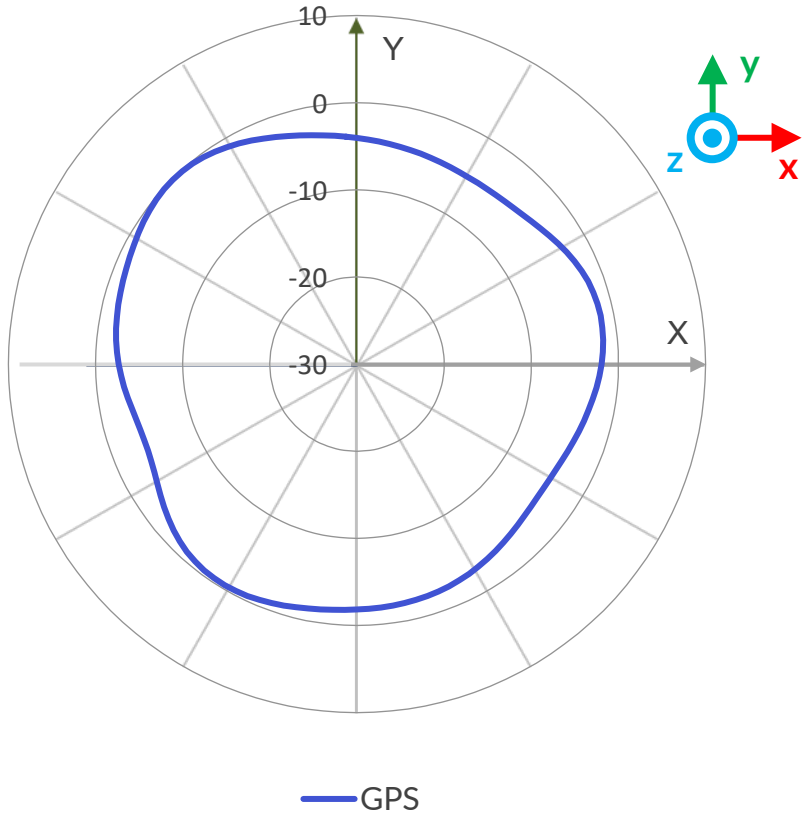
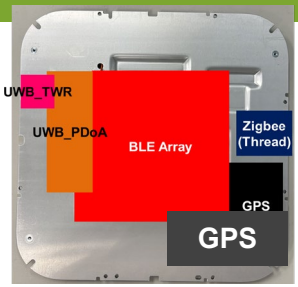
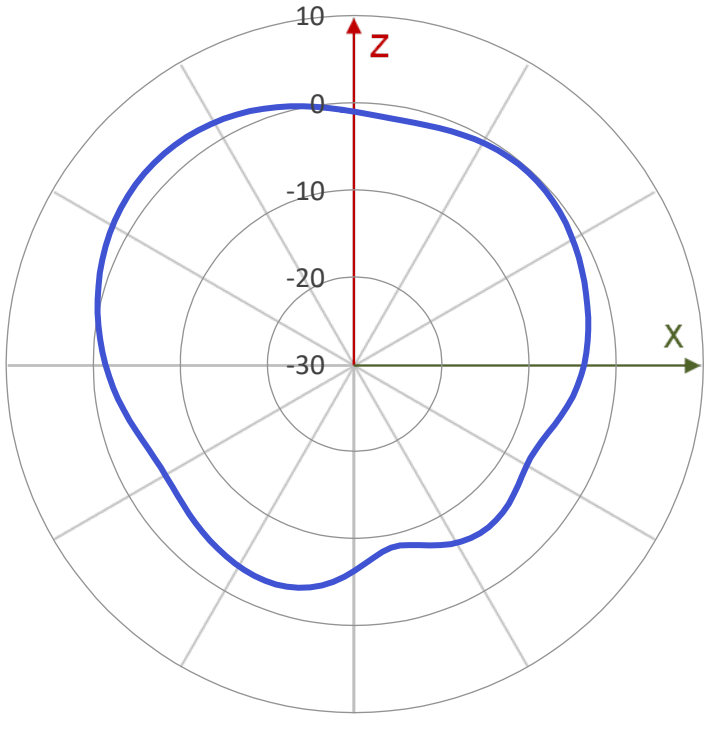


Realized Gain Pattern GPS @1176MHz for Gtotal

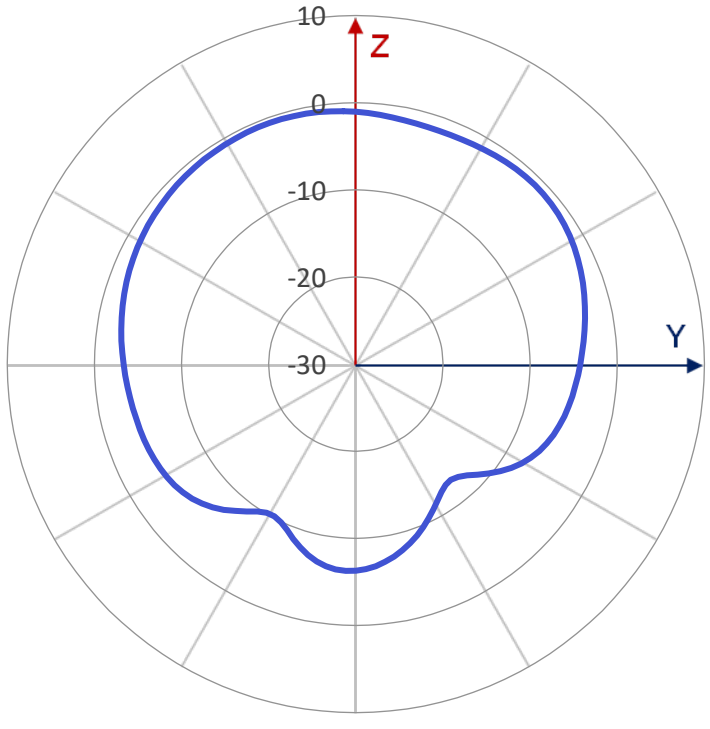


phi = 0



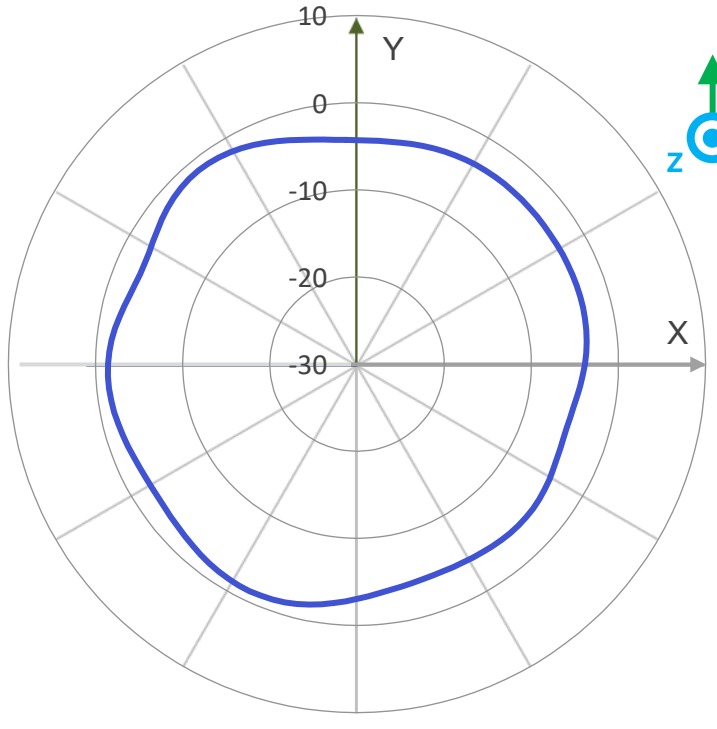
GPS

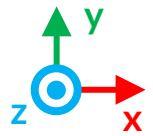
phi = 90



GPS

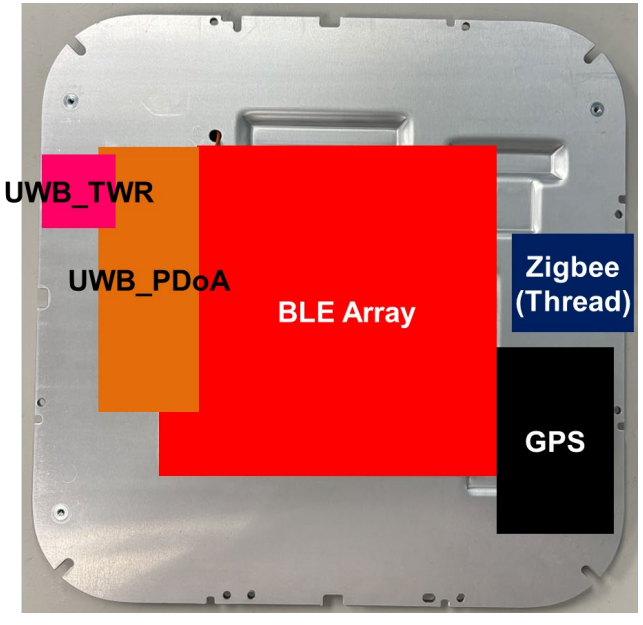
theta = 90





GPS

UWB_TWR

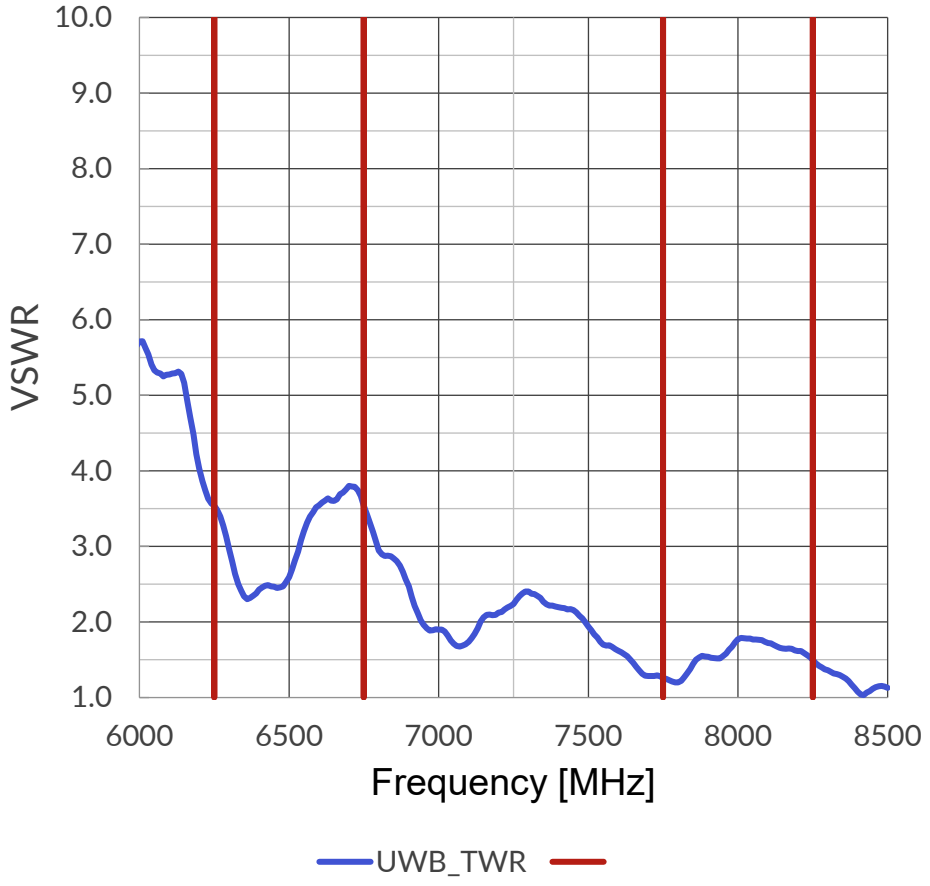


- **Maximum VSWR**
  - 1.8:1 on Ch9
- **Average Efficiency**
  - ~61% on Ch9
- **Peak Gain**
  - 4.7dBi on Ch9

- **Cable Length**

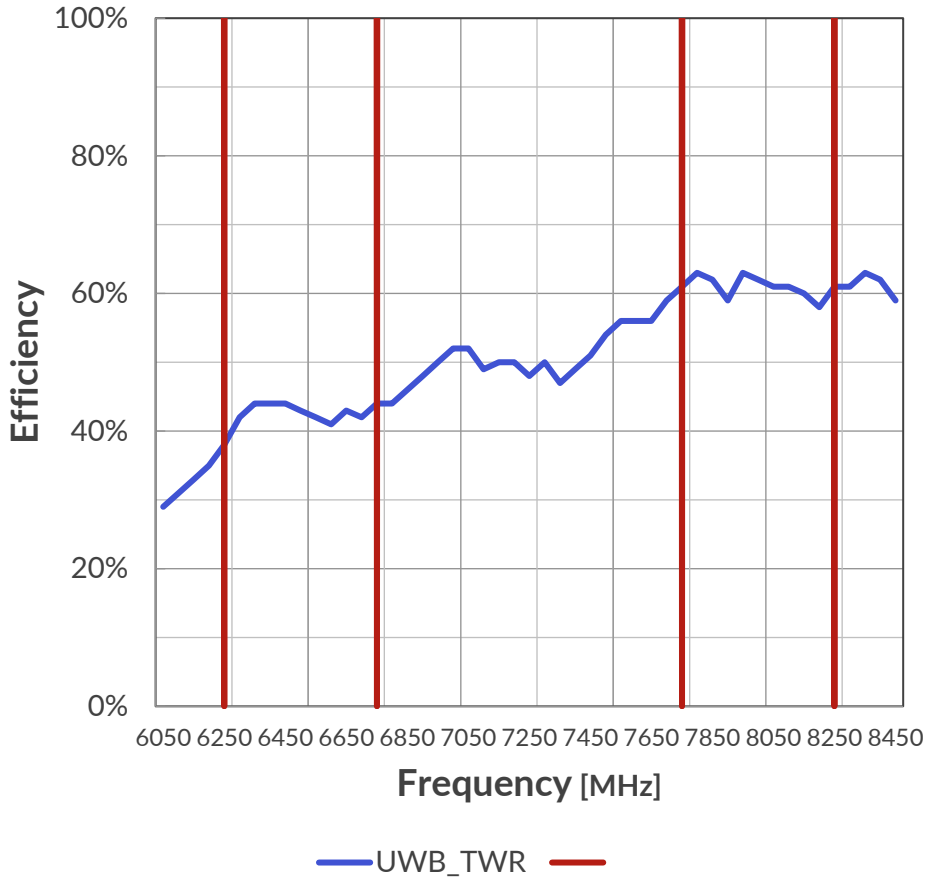
  UWB-TWR：142mm

VSWR UWB_TWR



Ch9	Max	Mean	Min
UWB_TWR	1.8	1.6	1.2

Efficiency UWB_TWR

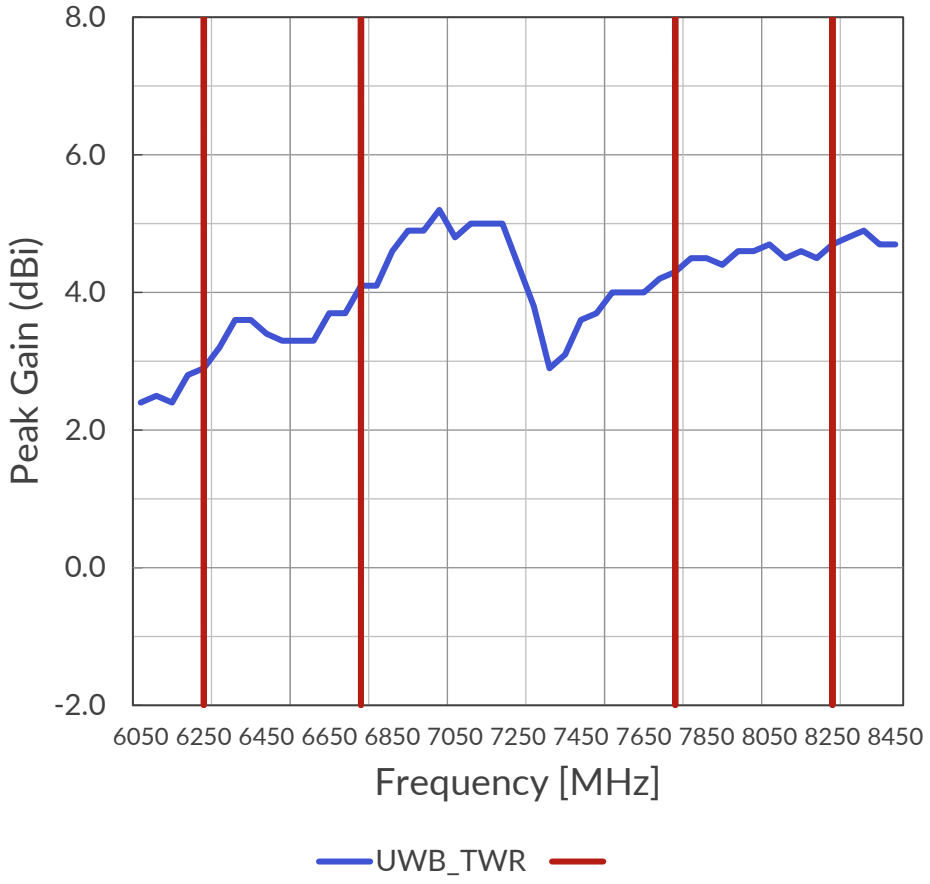


Ch9	Max	Mean	Min
UWB_TWR	63 %	61 %	58 %

- Cable Length

  UWB_TWR：142mm

Peak Gain UWB_TWR



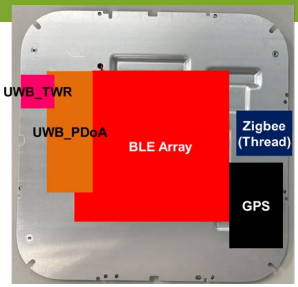
Ch9	Max	Mean	Min
UWB_TWR	4.7 dBi	4.5 dBi	4.3 dBi

- **Cable Length**

  UWB_TWR：142mm

Realized Gain Pattern

UWB_TWR @8000MHz for Gtotal



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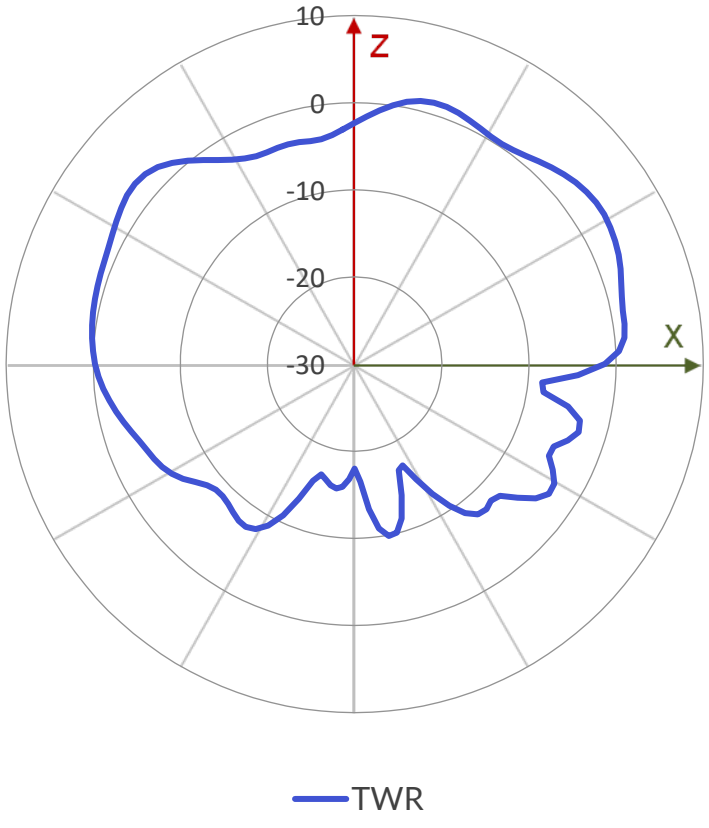

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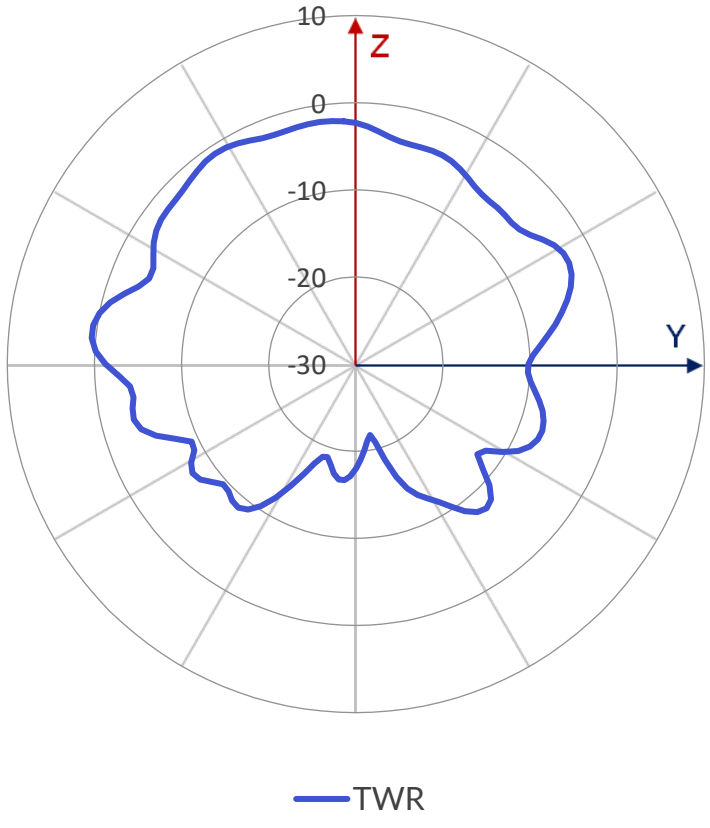

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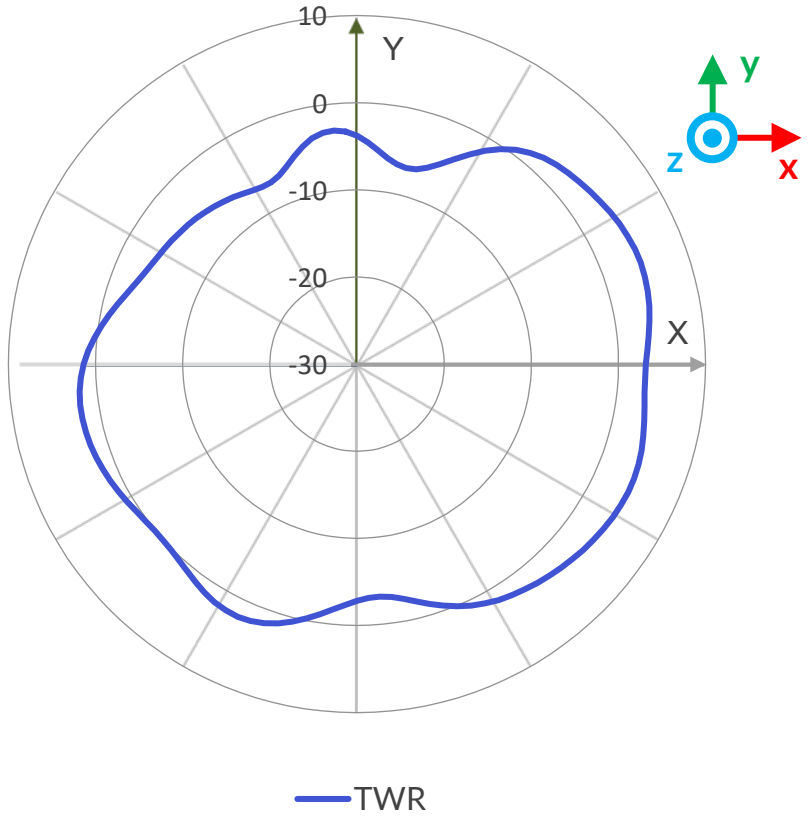
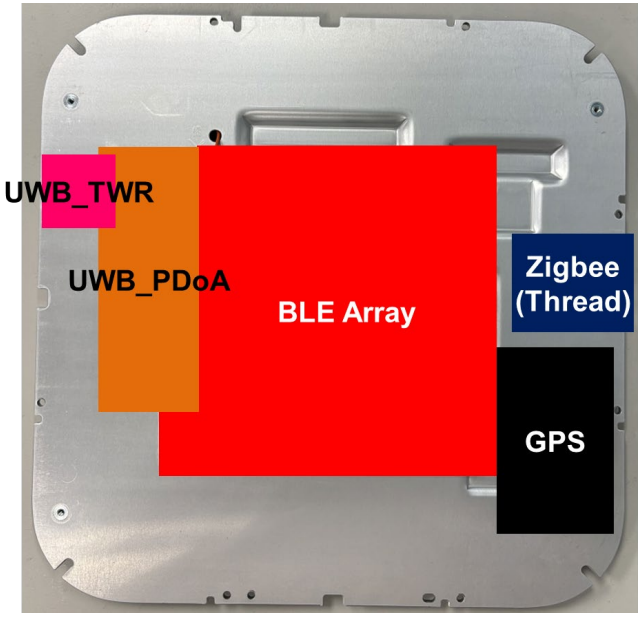
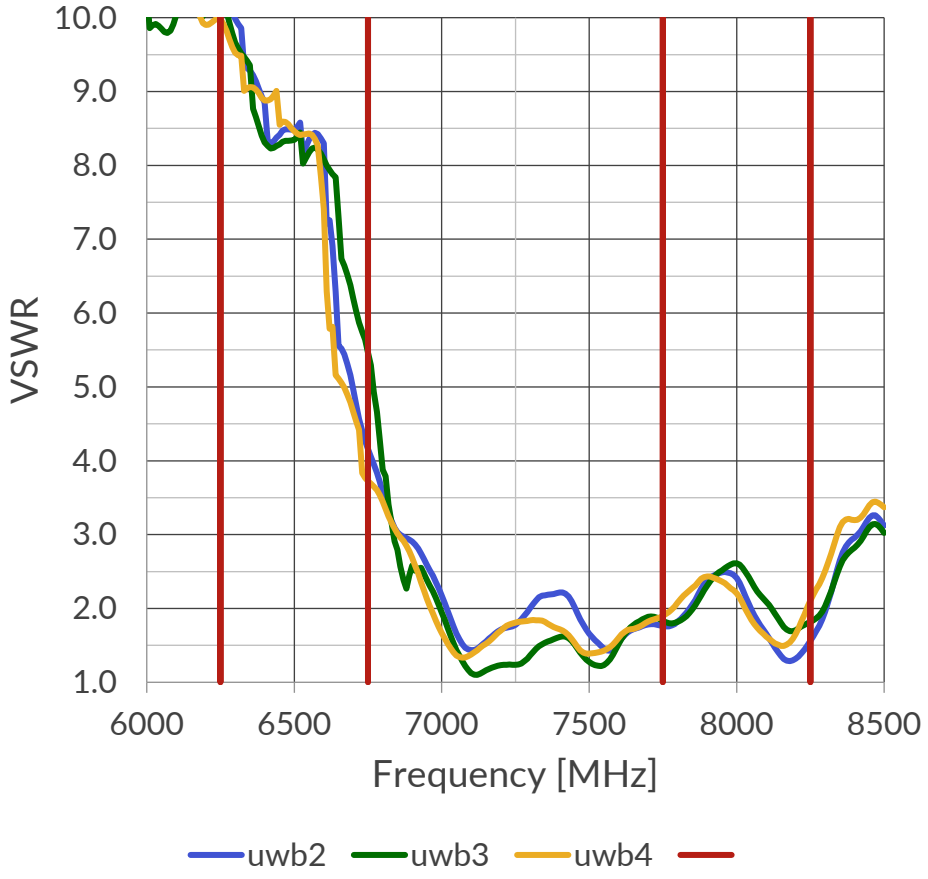


UWB_PDoA



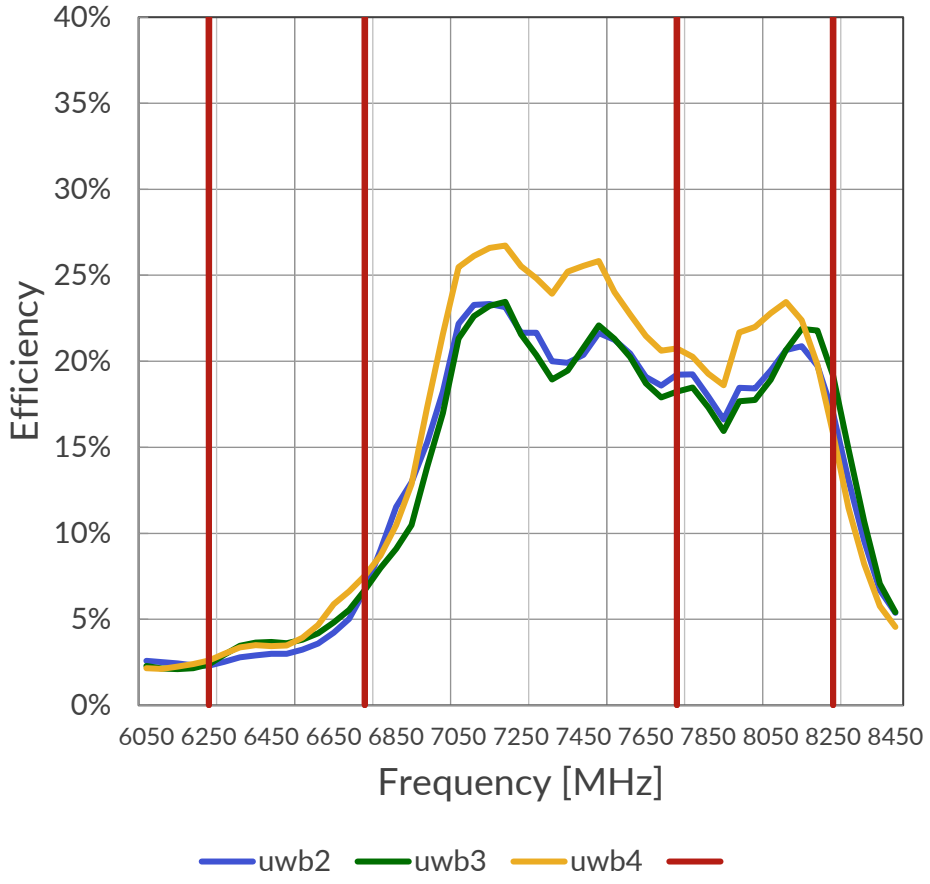
- **Maximum VSWR**
  - 2.6:1 on Ch9
- **Average Efficiency**
  - ~19% on Ch9
- **Peak Gain**
  - 2.1dBi on Ch9

VSWR UWB_PDoA



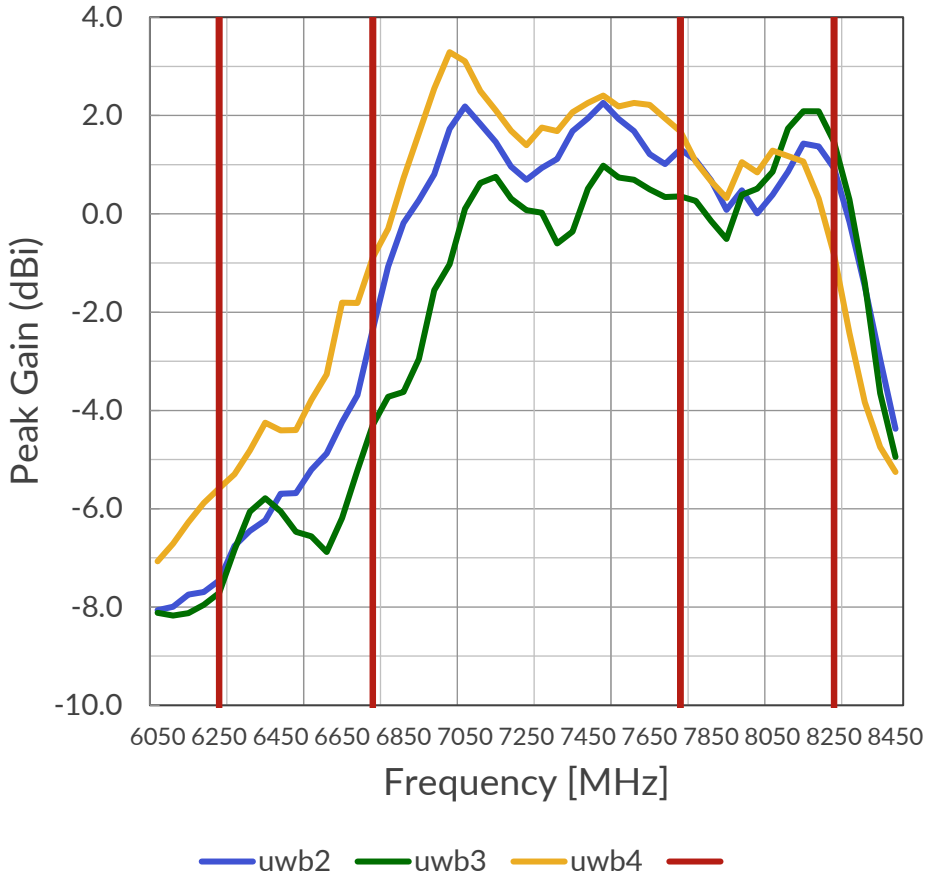
Ch9	Max	Mean	Min
uwb2	2.5	1.9	1.3
uwb3	2.6	2.1	1.7
uwb4	2.4	2.0	1.5
Summary	2.6	2.0	1.3

Efficiency UWB_PDoA



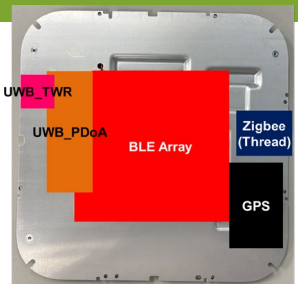
Ch9	Max	Mean	Min
uwb2	21 %	19 %	17 %
uwb3	22 %	19 %	16 %
uwb4	23 %	21 %	16 %
Summary	23 %	19 %	16 %

Peak Gain UWB_PDoA



Ch9	Max	Mean	Min
uwb2	1.4 dBi	0.8 dBi	0.0 dBi
uwb3	2.1 dBi	0.8 dBi	-0.5 dBi
uwb4	1.7 dBi	0.8 dBi	-0.8 dBi
Summary	2.1 dBi	0.8 dBi	-0.8 dBi

Realized Gain Pattern UWB_PDoA @8000MHz for Gtotal



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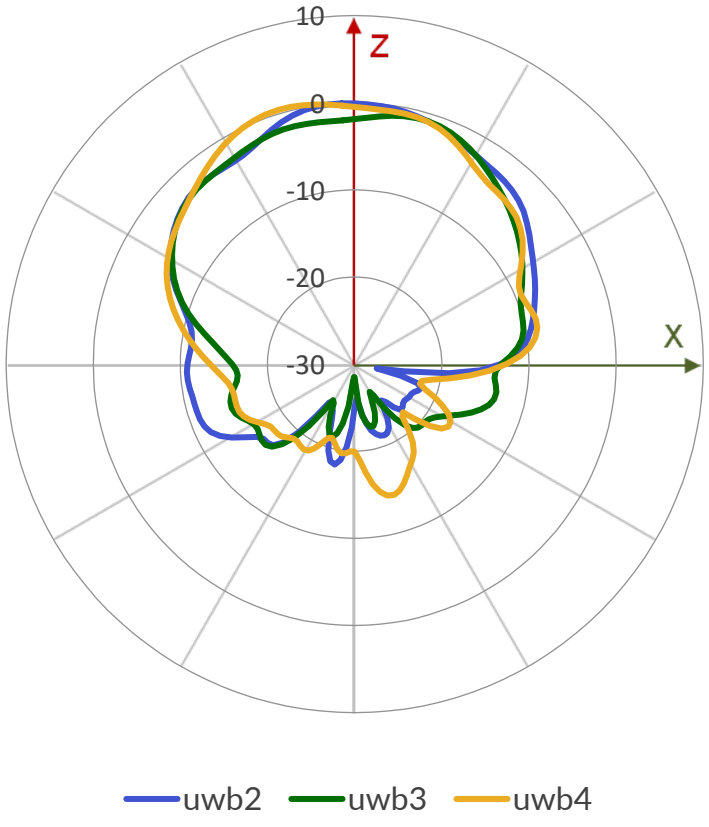

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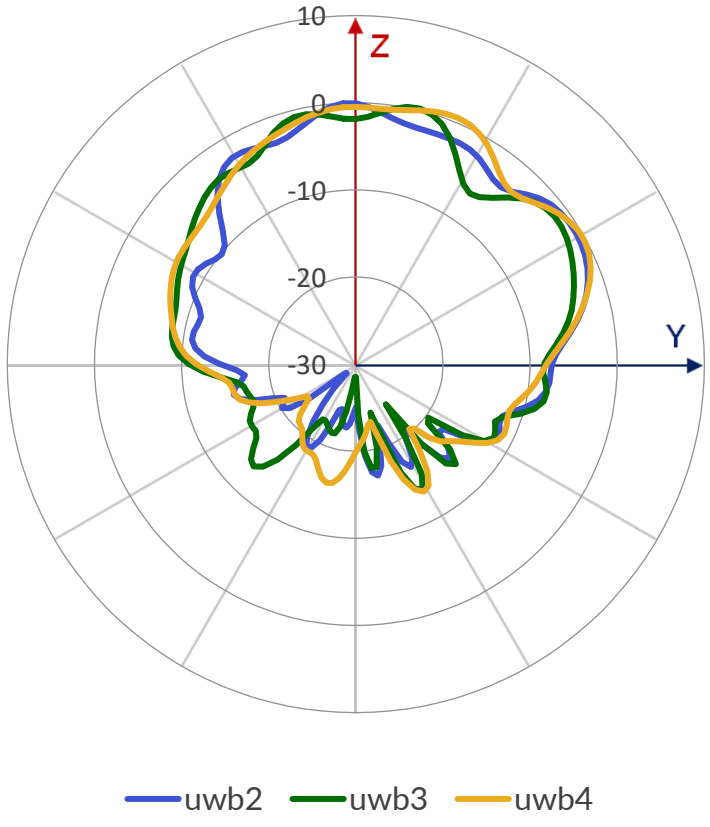

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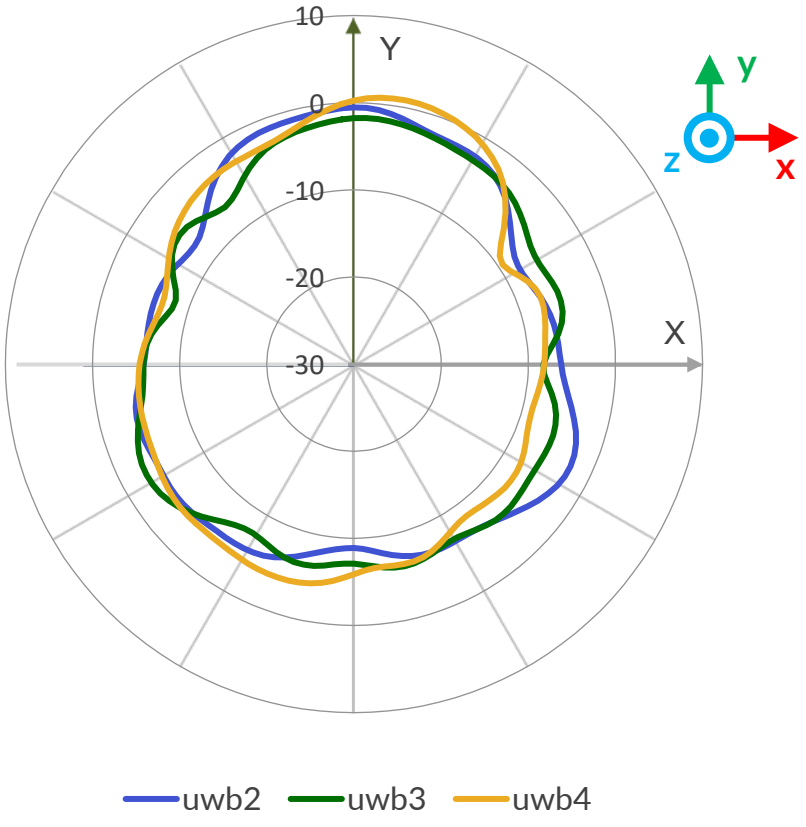
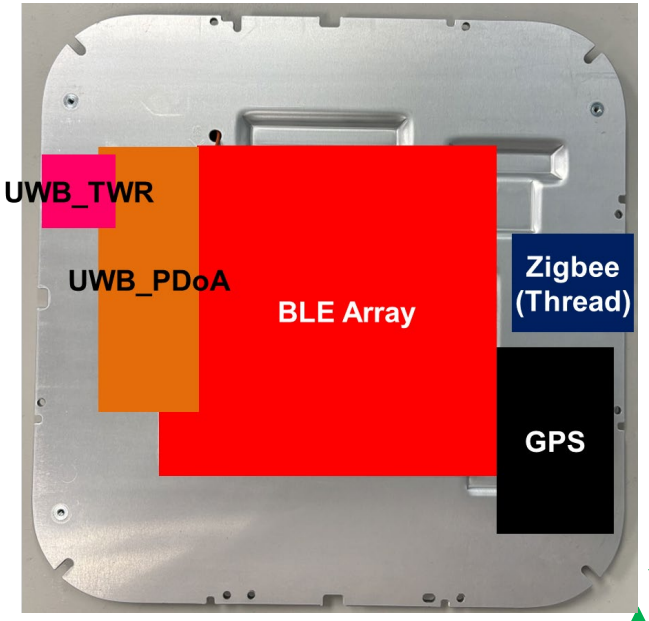
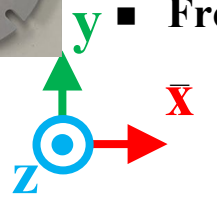


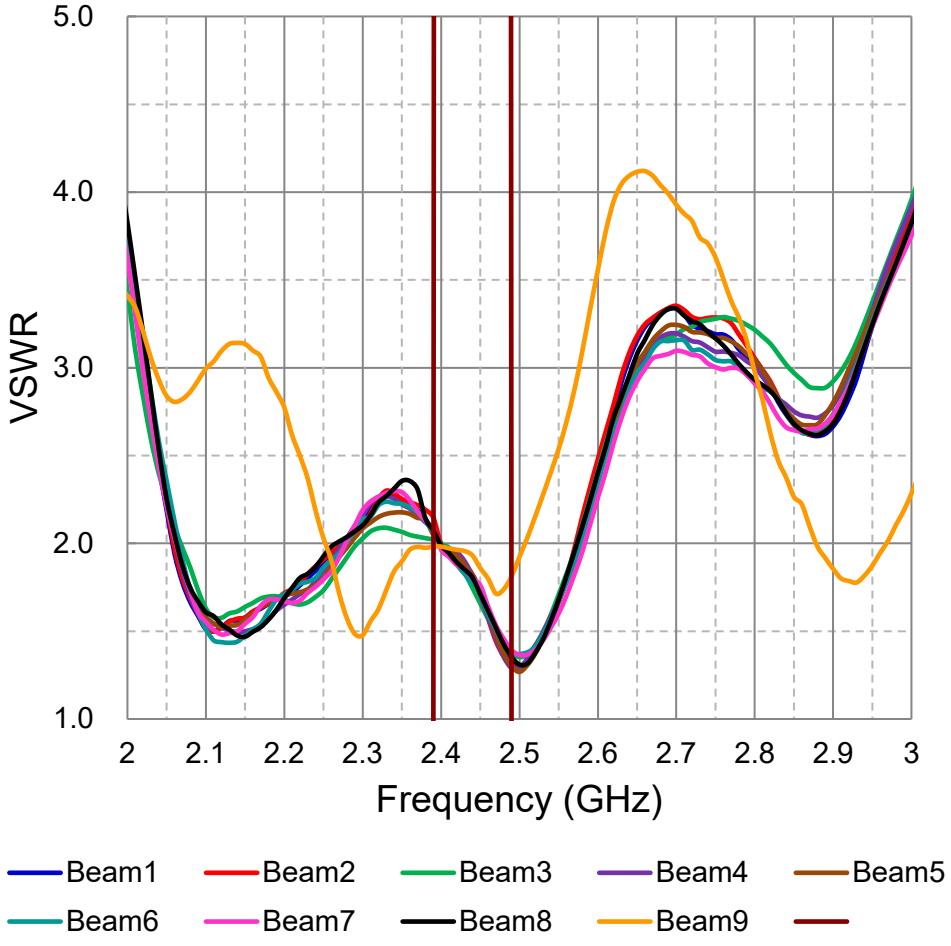
BLE Array – Directional Beam



- **Average Efficiency**
  - ~15% on 2.4GHz [Beam1~Beam8]
  - ~25% on 2.4GHz [Beam9]
- **Peak Gain**
  - 4.0dBi on 2.4GHz [Beam1~Beam8]
  - 2.6dBi on 2.4GHz [Beam9]
- **Beam Width**
  - ~46° on 2.4GHz [Beam1~Beam8]
- **Front to Back Ratio**
  - ~11.6dB on 2.4GHz [Beam1~Beam8]

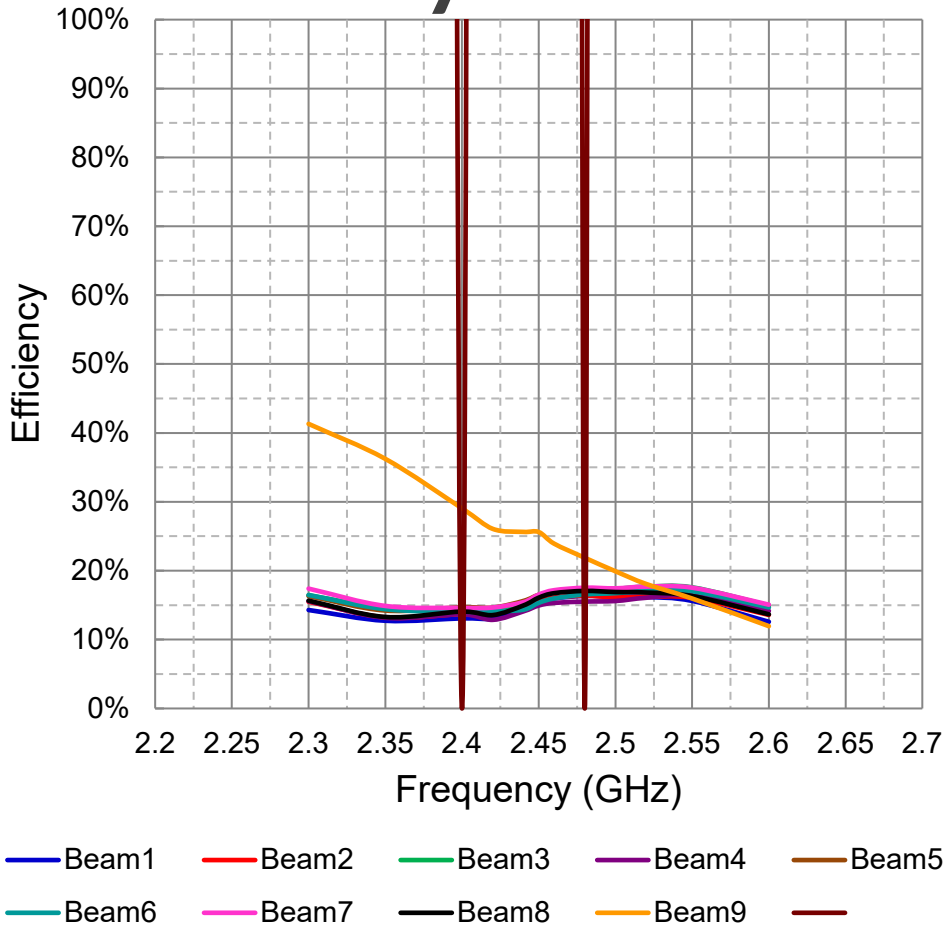


VSWR Directional Beam



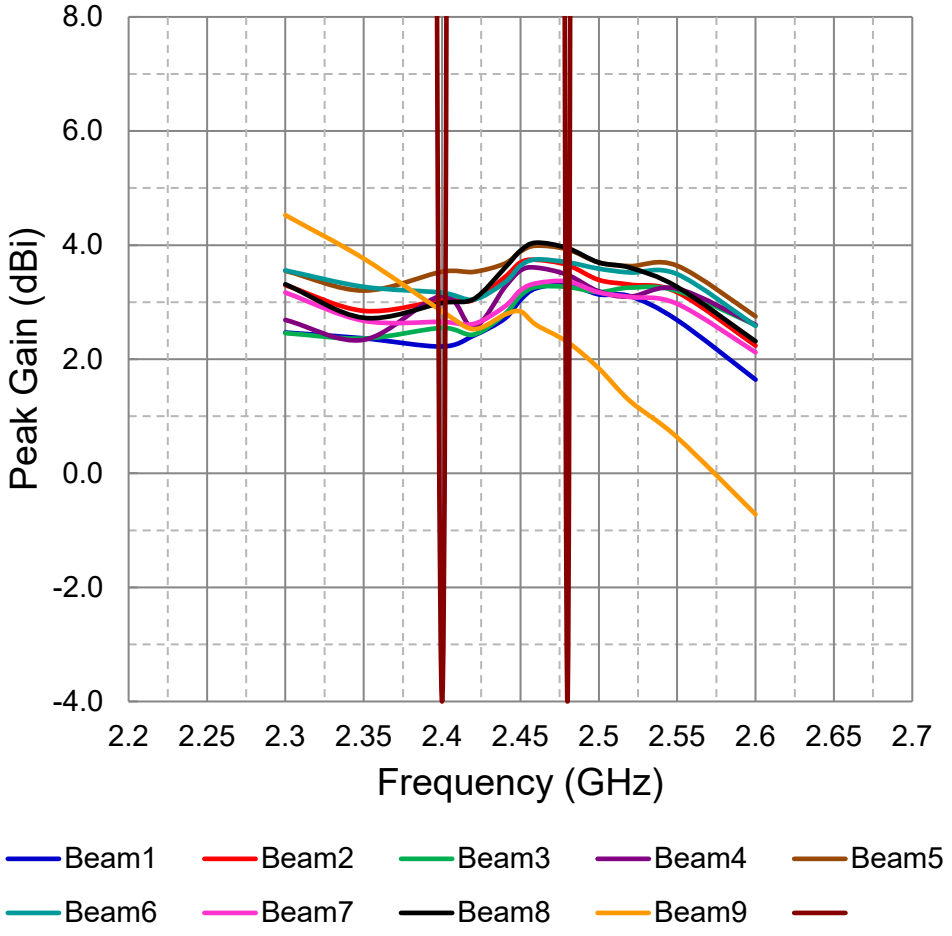
2.4GHz	Max	Mean	Min
beam1	2.0	1.7	1.4
beam2	2.0	1.7	1.4
beam3	2.0	1.7	1.4
beam4	2.0	1.7	1.4
beam5	2.0	1.8	1.4
beam6	2.0	1.7	1.4
beam7	2.0	1.8	1.5
beam8	2.0	1.8	1.4
beam9	2.0	1.9	1.7

Efficiency Directional Beam



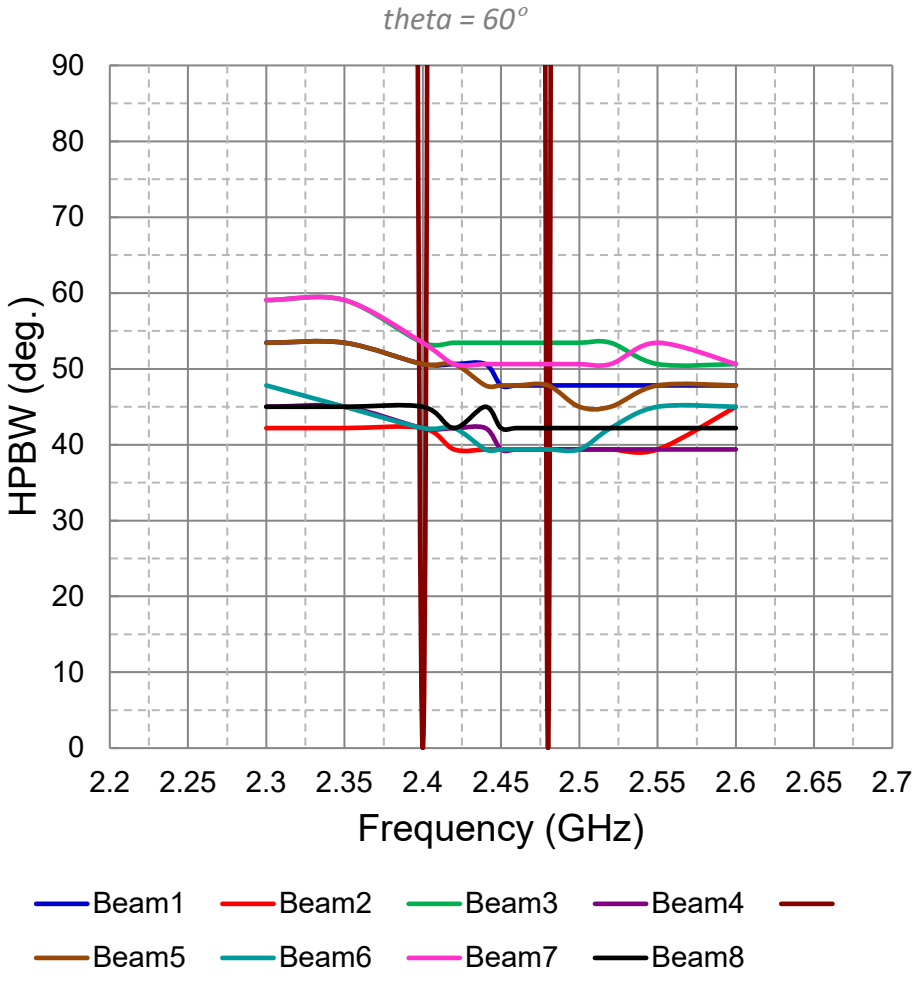
2.4GHz	Max	Mean	Min
Beam1	16 %	15 %	13 %
Beam2	16 %	15 %	14 %
Beam3	17 %	16 %	14 %
Beam4	16 %	14 %	13 %
Beam5	17 %	16 %	15 %
Beam6	17 %	15 %	14 %
Beam7	18 %	16 %	15 %
Beam8	17 %	15 %	14 %
Beam9	29 %	25 %	22 %

Peak Gain Directional Beam



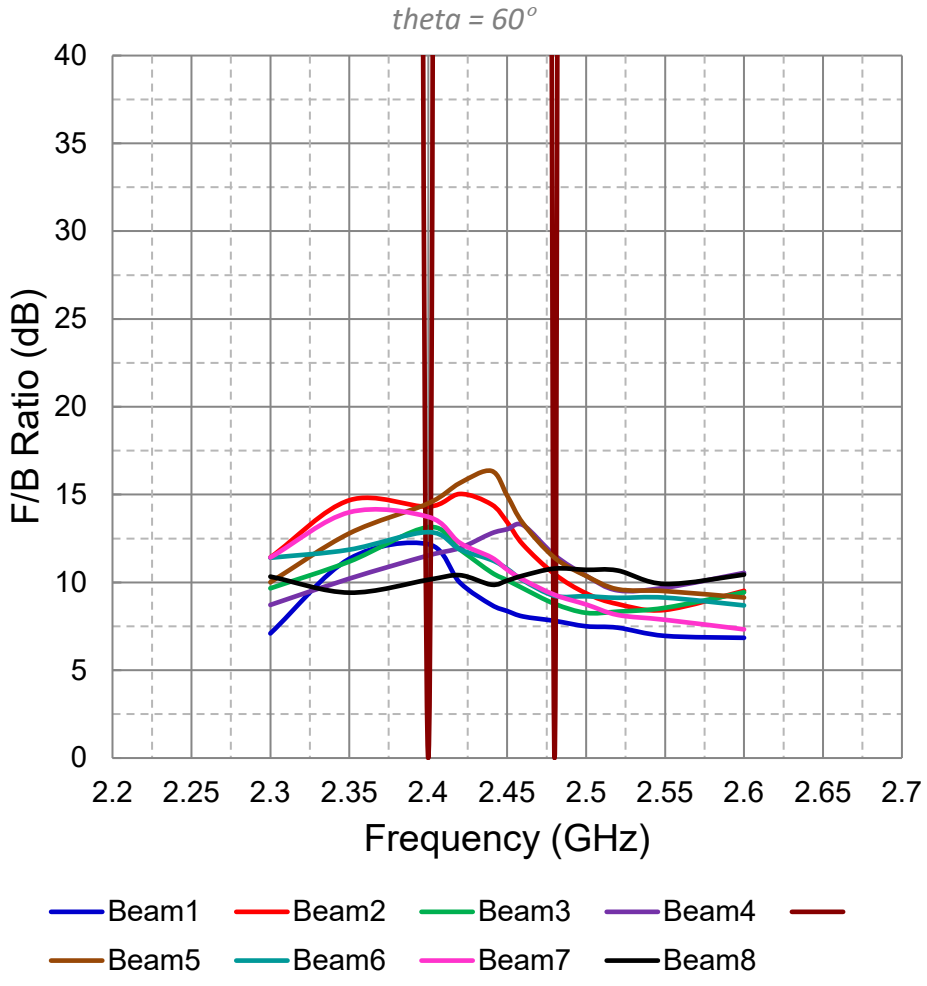
2.4GHz	Max	Mean	Min
Beam1	3.3 dBi	2.8 dBi	2.2 dBi
Beam2	3.7 dBi	3.4 dBi	3.0 dBi
Beam3	3.3 dBi	2.9 dBi	2.4 dBi
Beam4	3.6 dBi	3.3 dBi	2.6 dBi
Beam5	4.0 dBi	3.8 dBi	3.5 dBi
Beam6	3.7 dBi	3.4 dBi	3.0 dBi
Beam7	3.4 dBi	3.0 dBi	2.6 dBi
Beam8	4.0 dBi	3.6 dBi	3.0 dBi
Beam9	2.8 dBi	2.6 dBi	2.3 dBi

3dB Beam Width Directional Beam



2.4GHz	Max	Mean	Min
Beam1	51	49	48
Beam2	42	40	39
Beam3	53	53	53
Beam4	42	41	39
Beam5	51	49	48
Beam6	42	40	39
Beam7	53	51	51
Beam8	45	43	42
Summary	53	46	39

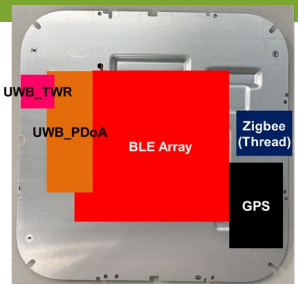
Front to Back Ratio Directional Beam



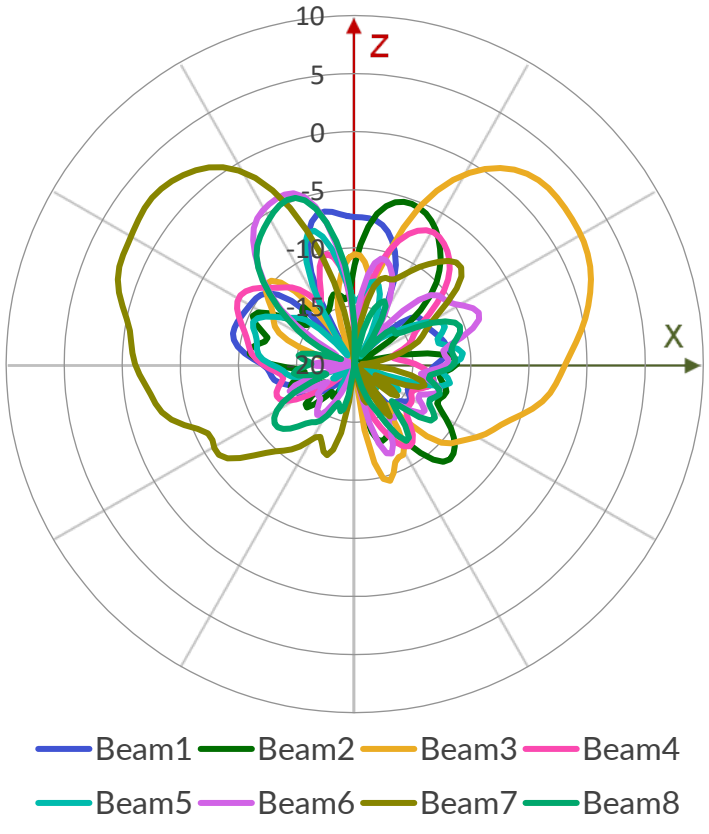
2.4GHz	Max	Mean	Min
Beam1	12.2	9.2	7.8
Beam2	15.0	13.3	10.5
Beam3	13.1	10.7	8.8
Beam4	13.3	12.4	11.5
Beam5	16.4	14.4	11.4
Beam6	12.9	11.0	9.2
Beam7	13.7	11.3	9.3
Beam8	10.8	10.3	9.9
Summary	16.4	11.6	7.8

Realized Gain Pattern

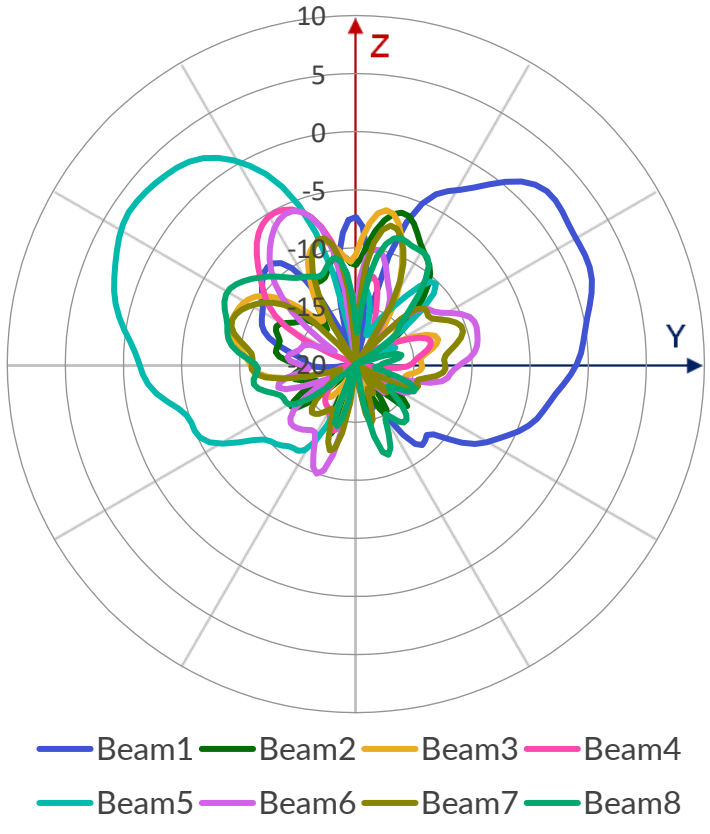
Directional Beam 1-8 @2400MHz for Gtotal



phi = 0



phi = 90



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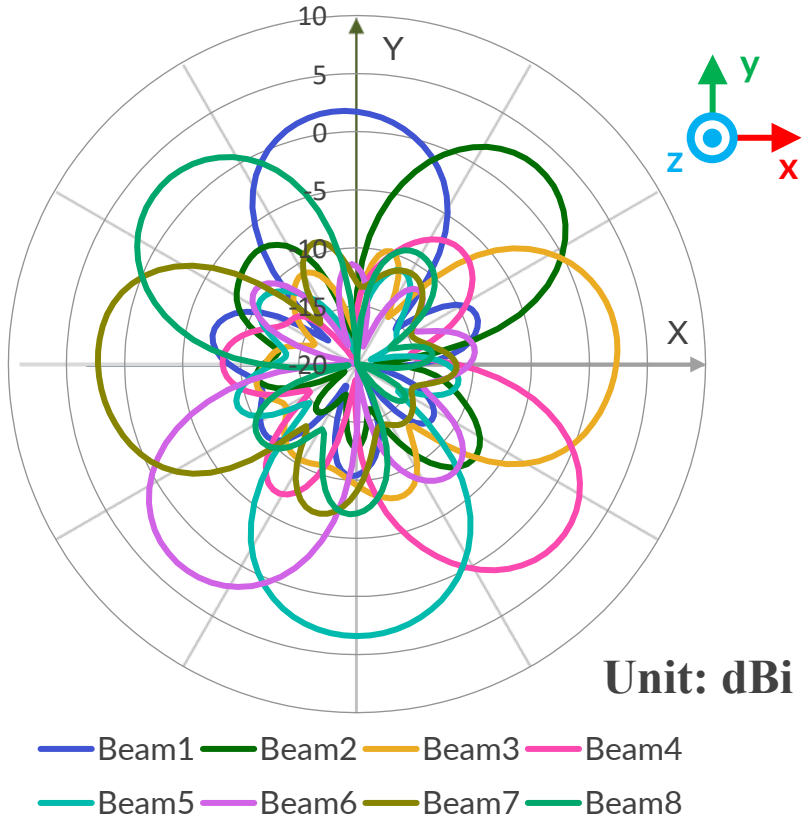
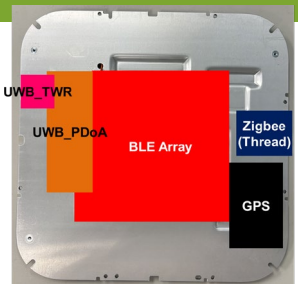
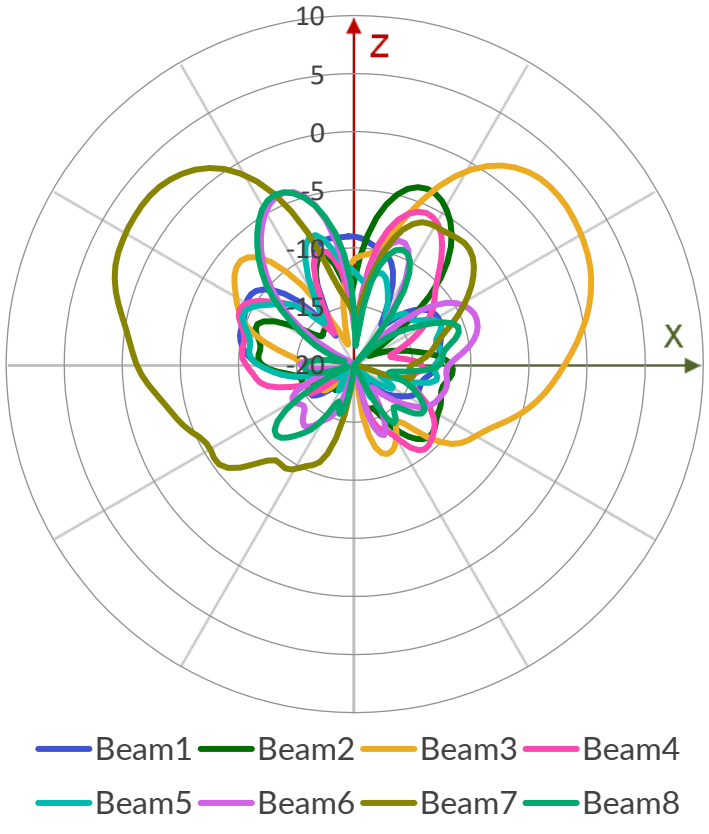


Realized Gain Pattern

Directional Beam 1-8 @2440MHz for Gtotal

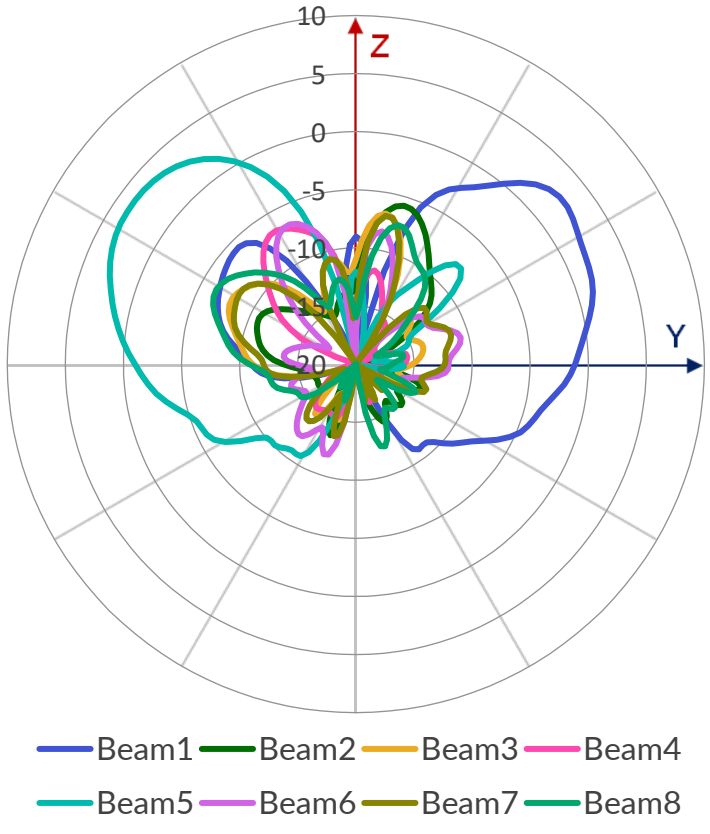


phi = 0



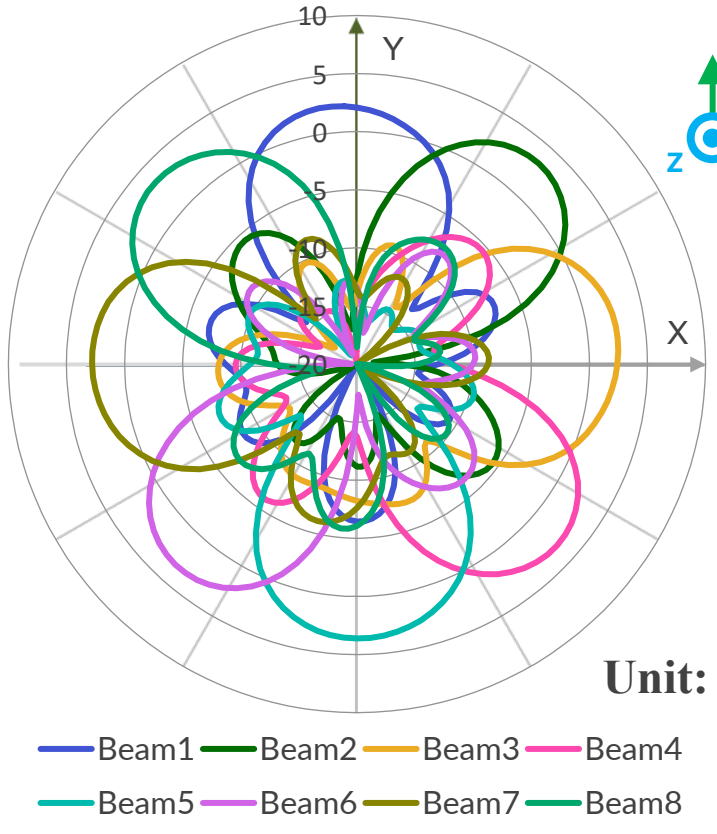
Beam1 Beam2 Beam3 Beam4
Beam5 Beam6 Beam7 Beam8

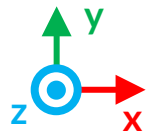
phi = 90



Beam1 Beam2 Beam3 Beam4
Beam5 Beam6 Beam7 Beam8

theta = 60



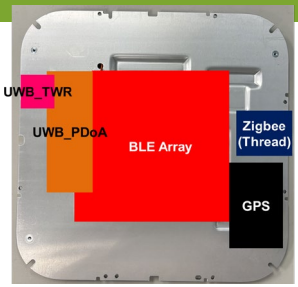


Unit: dBi

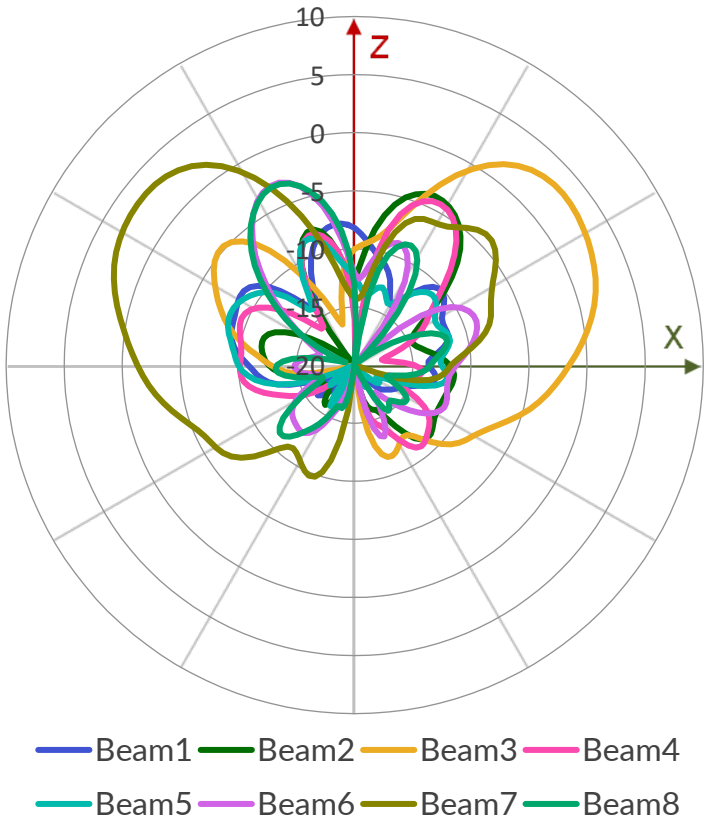
Beam1 Beam2 Beam3 Beam4
Beam5 Beam6 Beam7 Beam8

Realized Gain Pattern

Directional Beam 1-8 @2480MHz for Gtotal

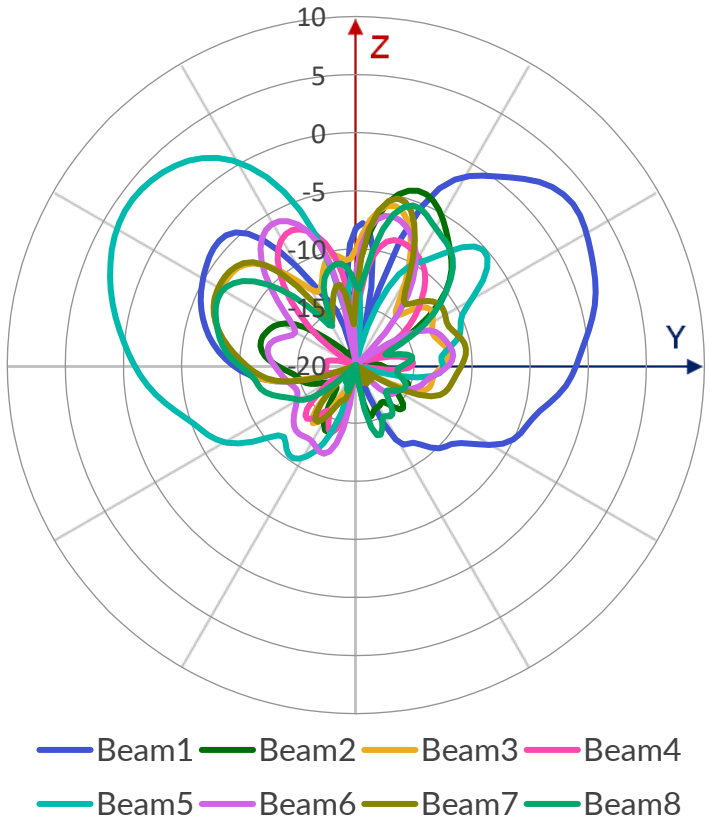


phi = 0



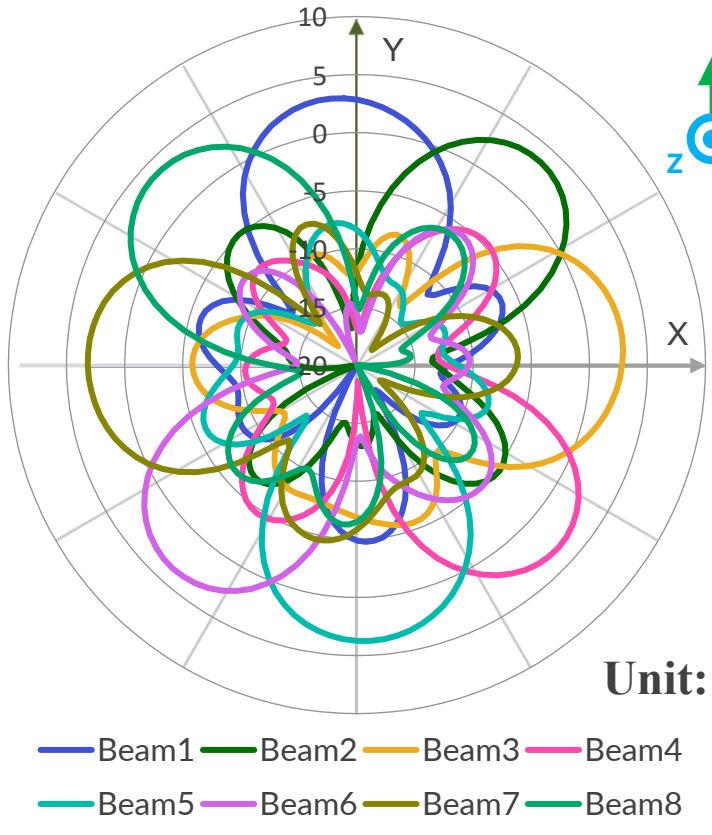
Beam1 Beam2 Beam3 Beam4
Beam5 Beam6 Beam7 Beam8

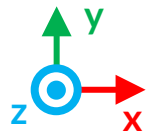
phi = 90



Beam1 Beam2 Beam3 Beam4
Beam5 Beam6 Beam7 Beam8

theta = 60



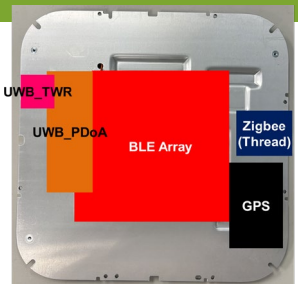


Unit: dBi

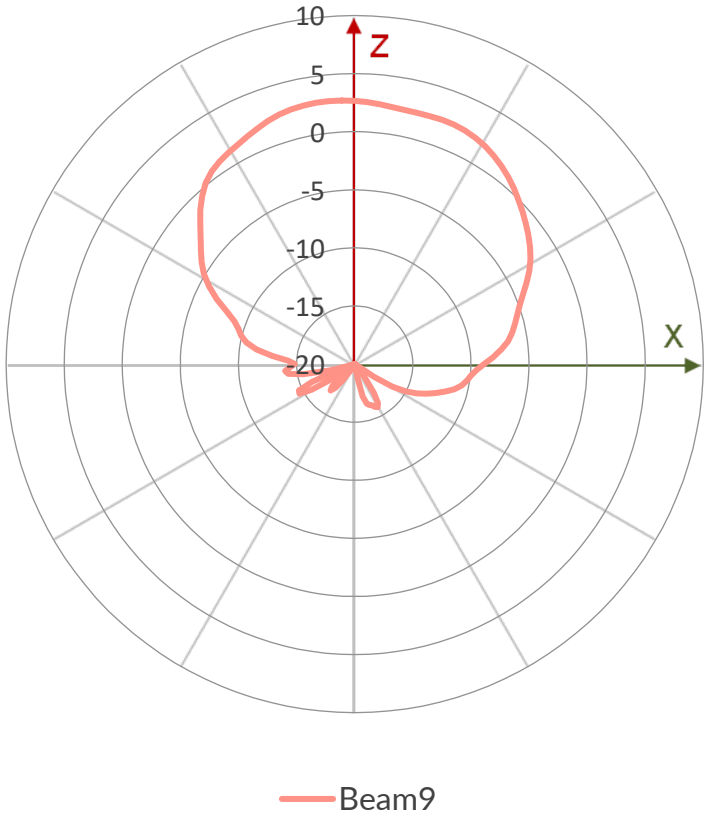
Beam1 Beam2 Beam3 Beam4
Beam5 Beam6 Beam7 Beam8

Realized Gain Pattern

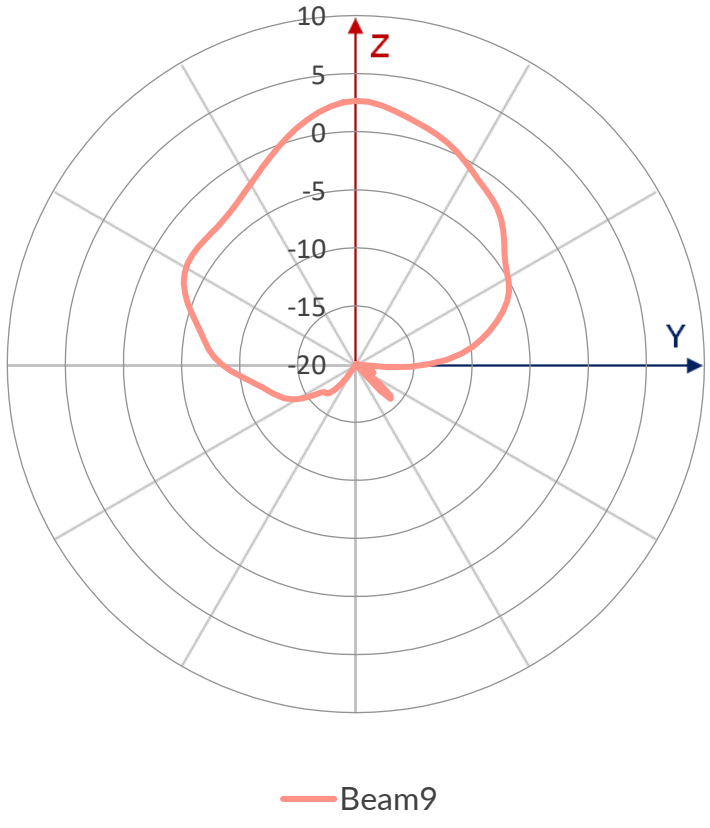
Directional Beam 9 @2400MHz for Gtotal



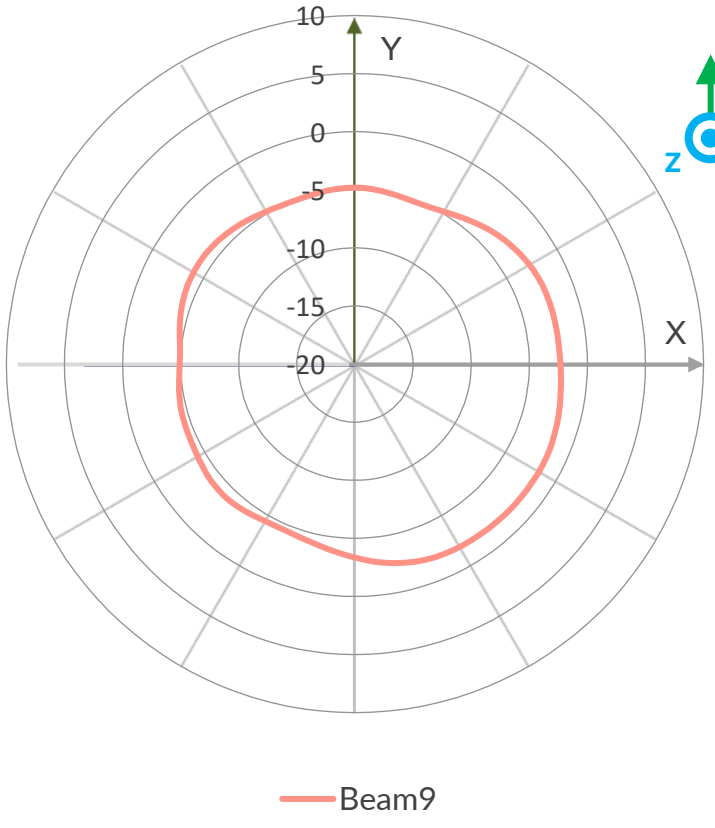
phi = 0

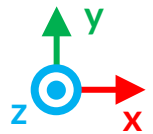


phi = 90



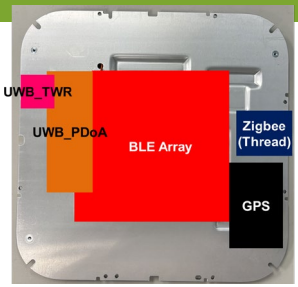
theta = 60



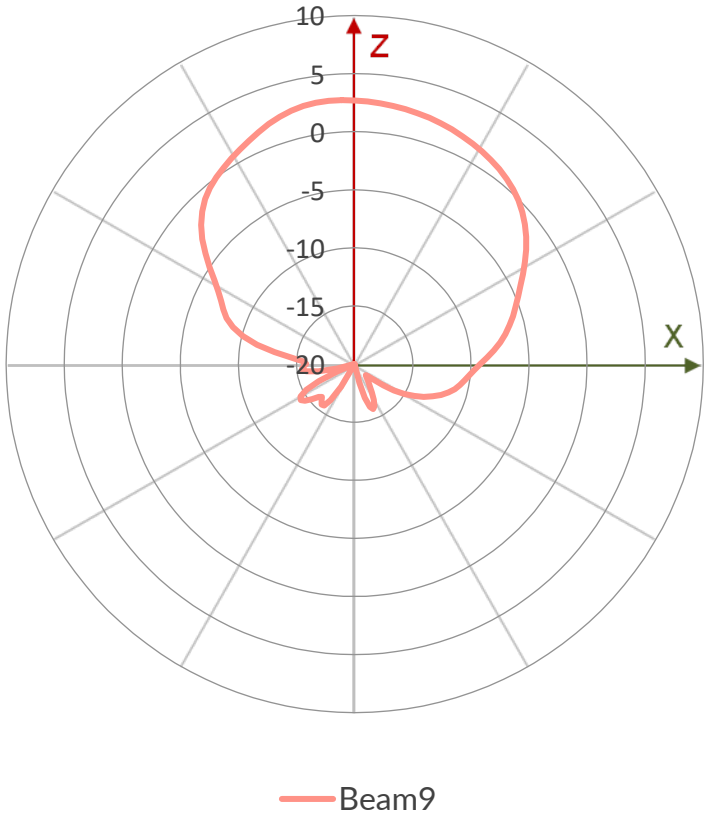


Realized Gain Pattern

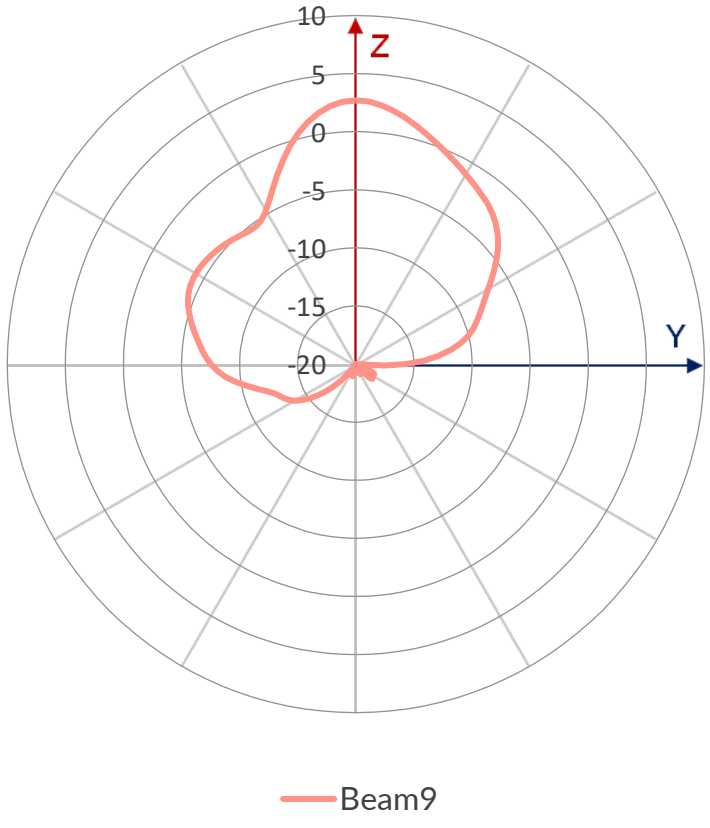
Directional Beam 9 @2440MHz for Gtotal



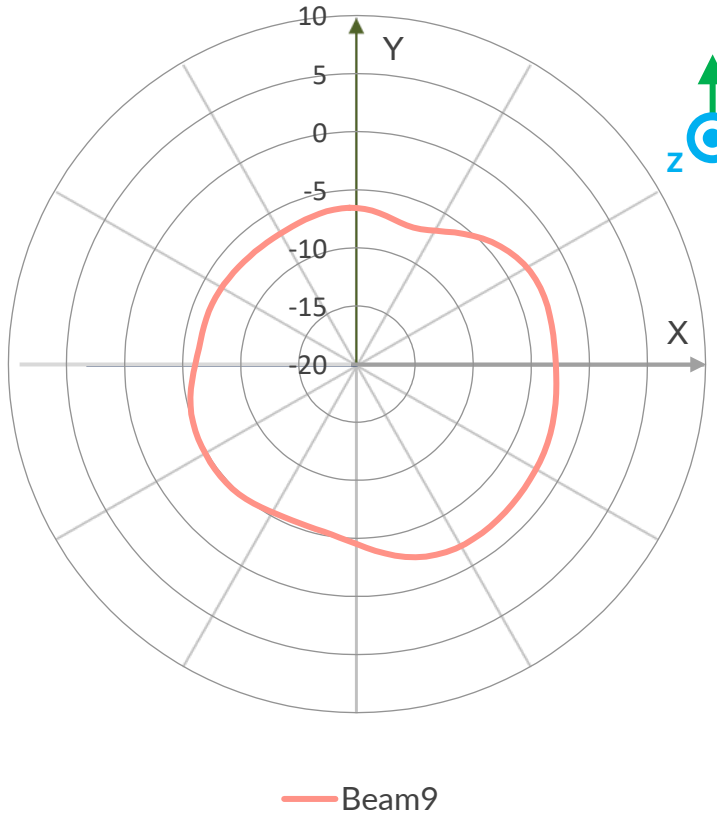
phi = 0

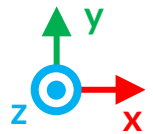


phi = 90



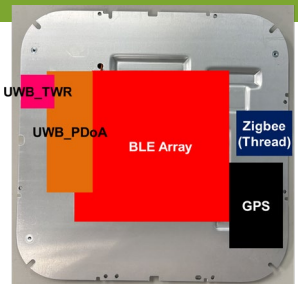
theta = 60





Realized Gain Pattern

Directional Beam 9 @2480MHz for Gtotal



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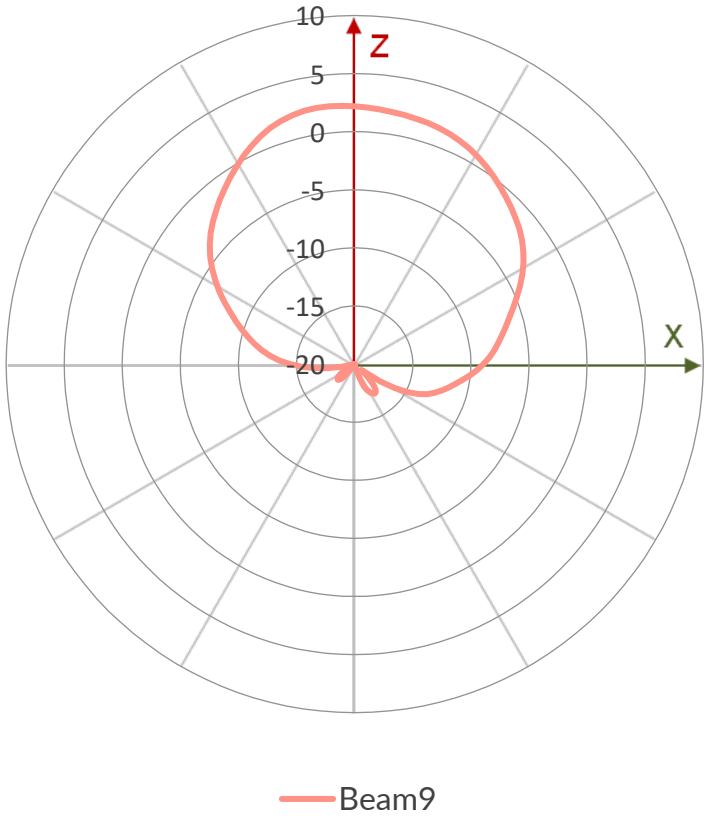

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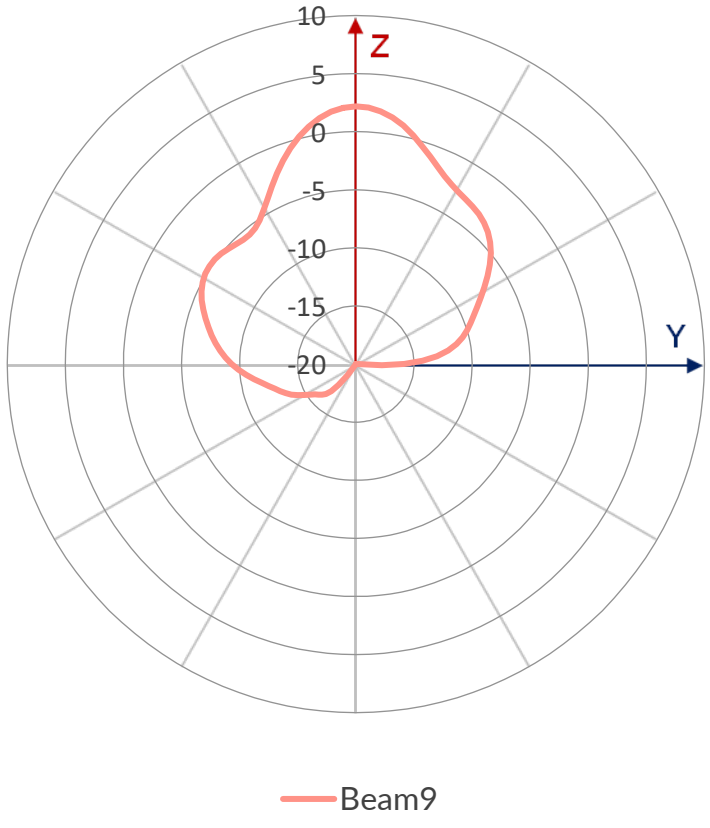
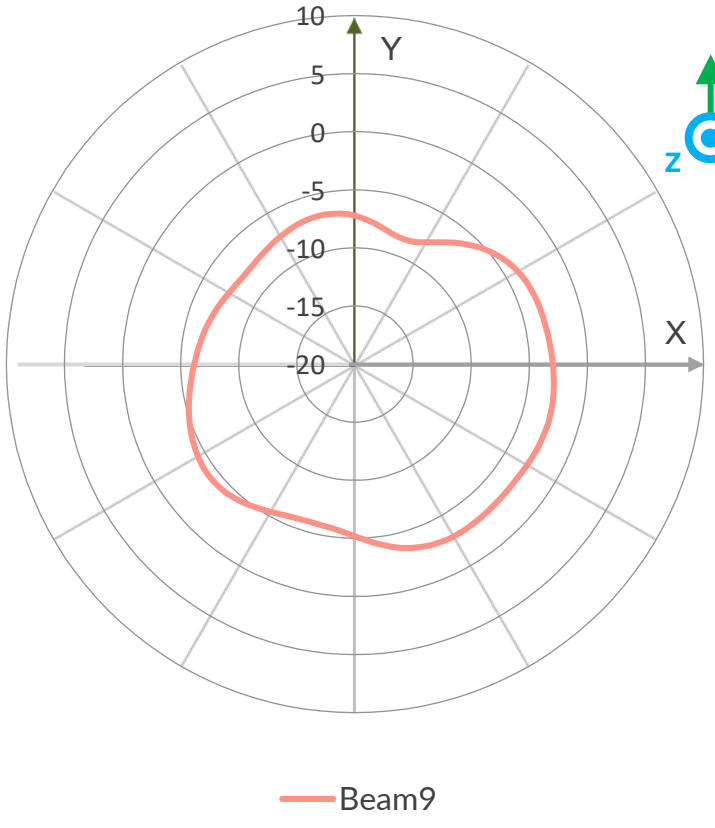
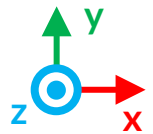
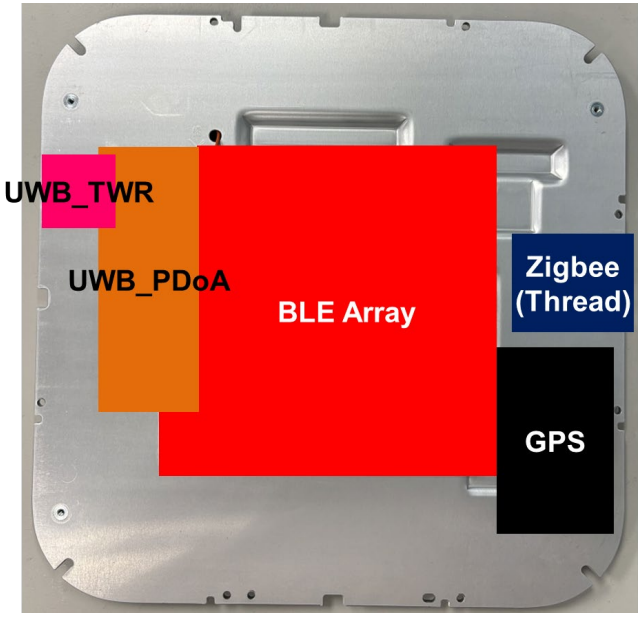


theta = 60

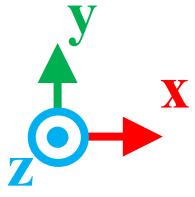




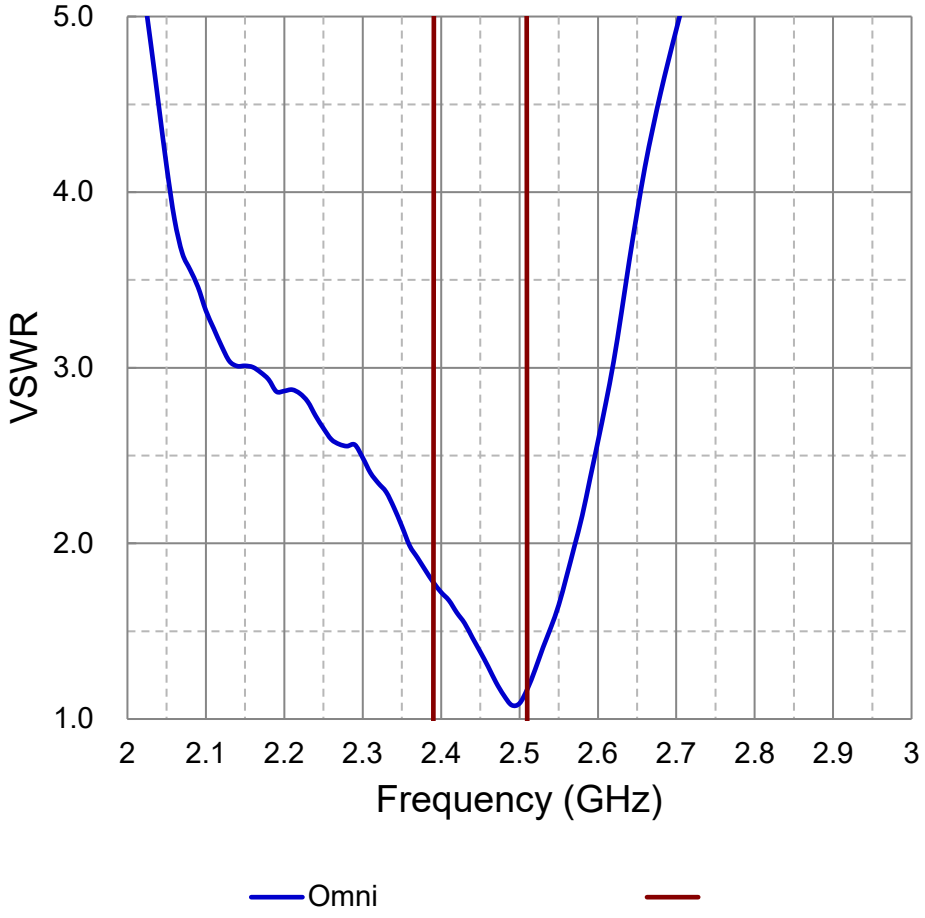
BLE Array – Omni Beam



- **Maximum VSWR**
  - 1.7:1 on 2.4GHz
- **Average Efficiency**
  - ~21% on 2.4GHz
- **Peak Gain**
  - 1.0dBi on 2.4GHz

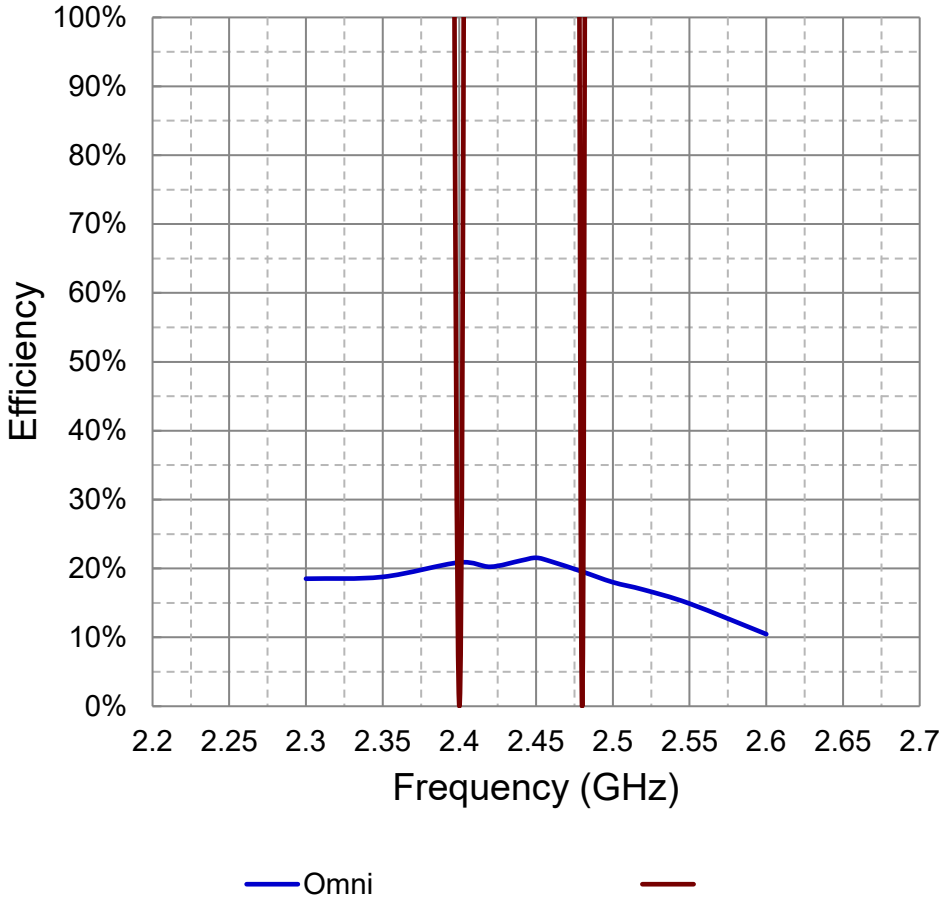


VSWR Omni Beam



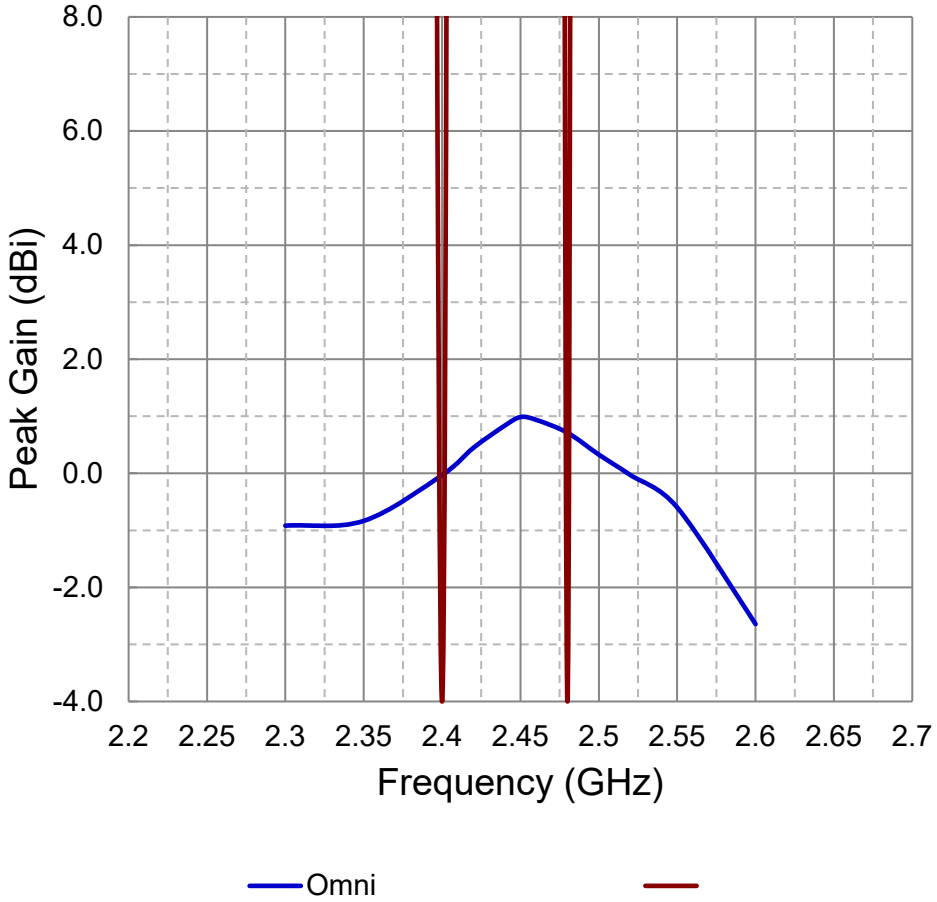
2.4GHz	Max	Mean	Min
Omni	1.7	1.4	1.1

Efficiency Omni Beam



2.4GHz	Max	Mean	Min
Omni	22 %	21 %	20 %

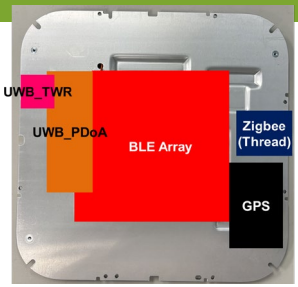
Peak Gain Omni Beam



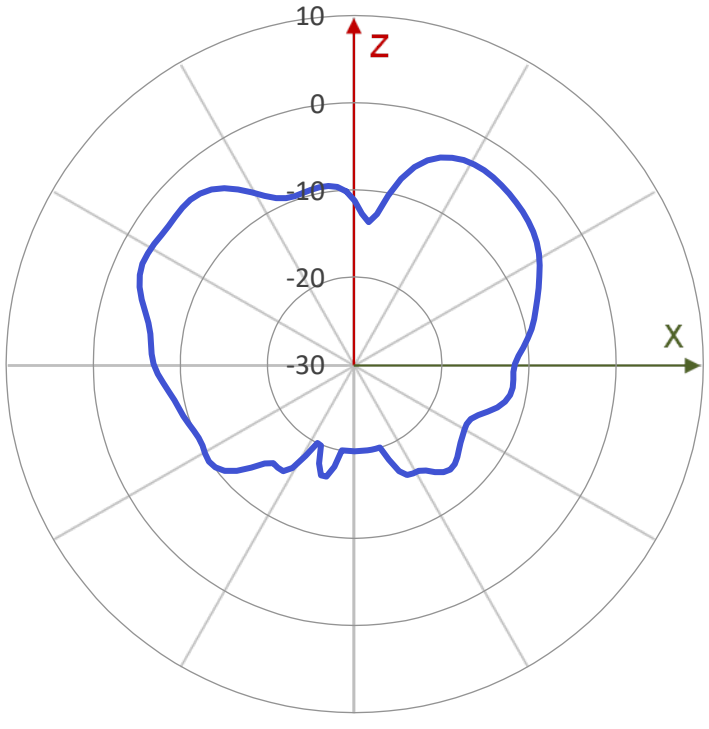
2.4GHz	Max	Mean	Min
Omni	1.0 dBi	0.6 dBi	-0.0 dBi

Realized Gain Pattern

Omni Beam @2440MHz for Gtotal

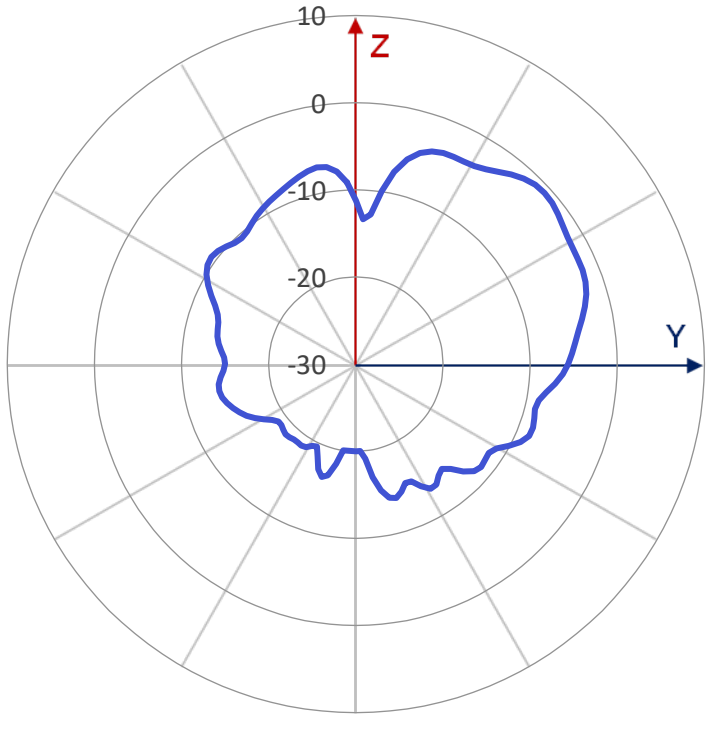


phi = 0



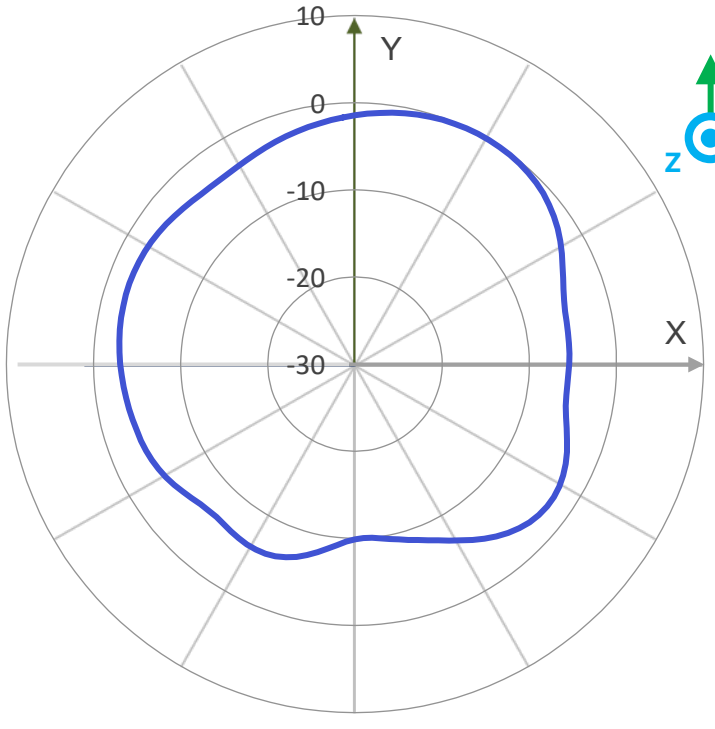
Omni

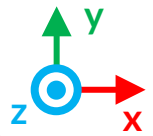
phi = 90



Omni

theta = 60





Omni