



JUNIPER AP47D ANTENNA REPORT

Brand: Juniper

Model: AP47D

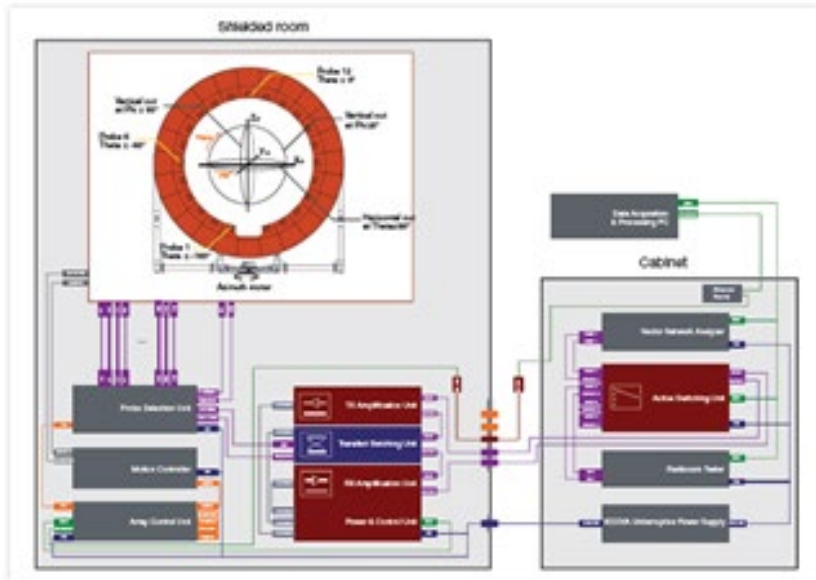


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Chamber Information

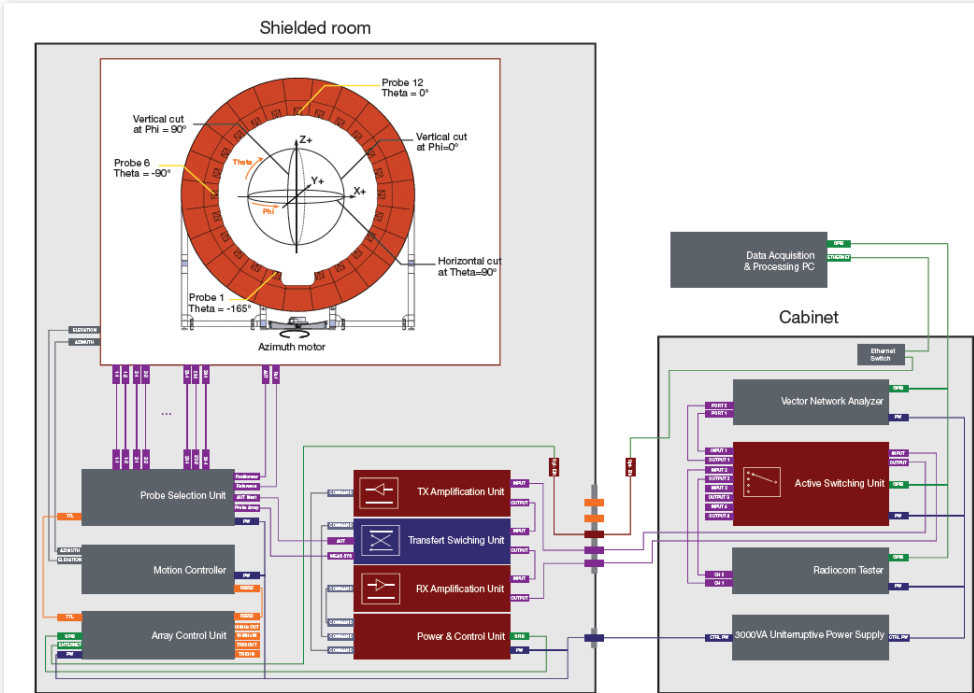
- Test Date : 20241014
- Test Engineer : Lucien Hsieh
- Measurement System : SATIMO SG24-L
- Software Name : Wave Studio
- Software Version : 22.5.6



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

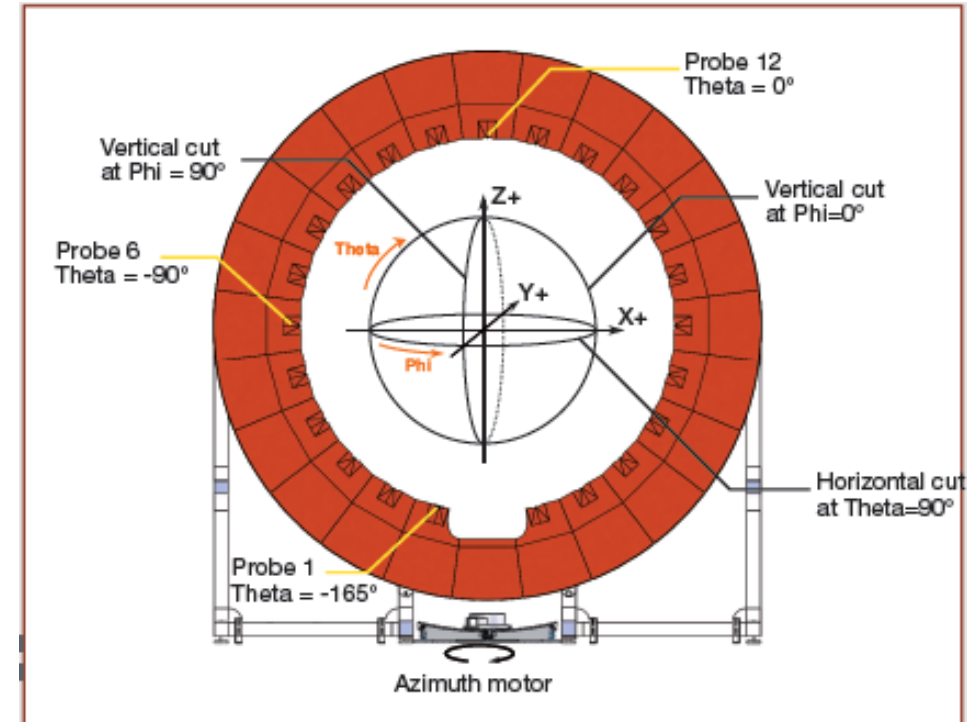
- Calibration Information



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.



Summary(1)

The summary of antenna performance are shown in below.

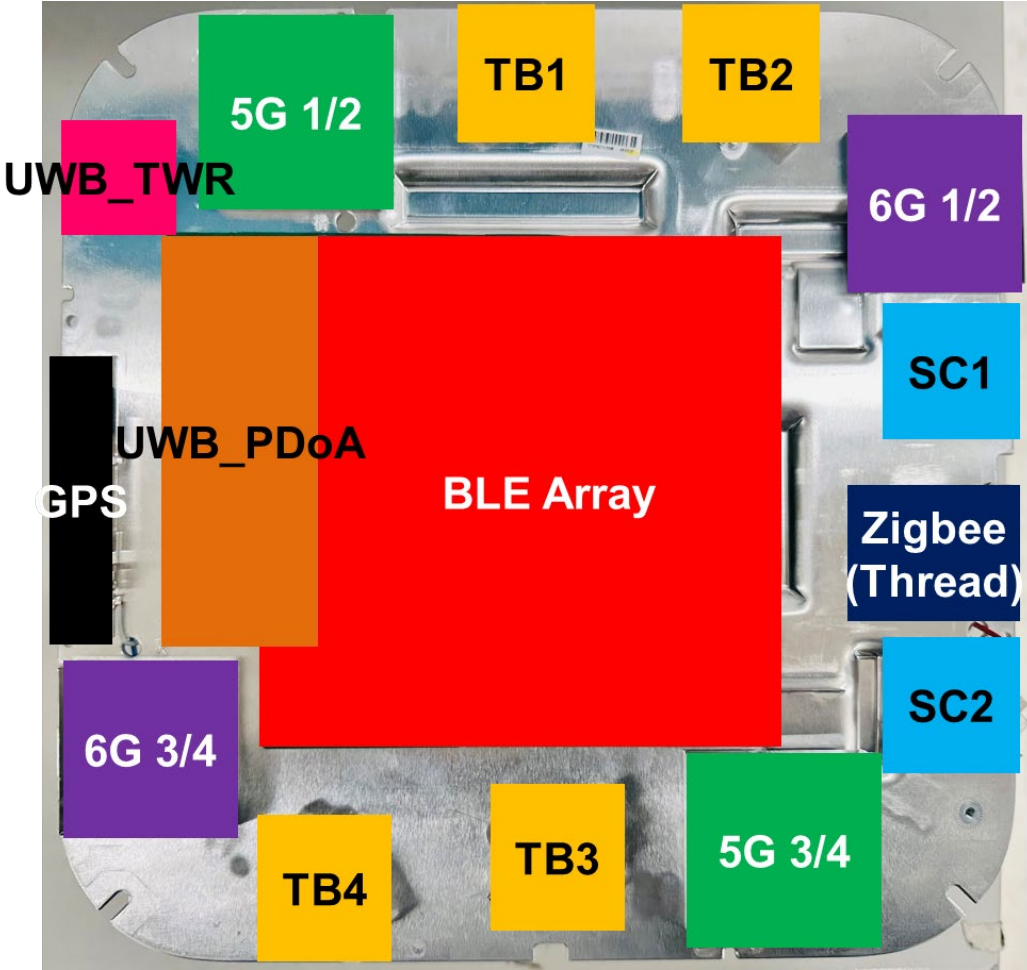
- Radiation efficiency
 - ~65% for 2.4GHz, ~60% for 5GHz, ~63% for 6GHz Wi-Fi Tri-band antennas [TB1, TB2, TB3, TB4]
 - ~60% for 5GHz Wi-Fi 5G antennas [5G1, 5G2, 5G3, 5G4]
 - ~60% for 6GHz Wi-Fi 6G antennas [6G1, 6G2, 6G3, 6G4]
 - ~64% for 2.4GHz ~65% for 5GHz, ~68% for 6GHz Scanning antennas [SC1, SC2]
 - ~58% for 2.4GHz Zigbee(Thread) antenna [Zigbee(Thread)]
 - ~51% for L1, ~74% for L5 GPS antenna [GPS]
 - ~55% for Ch9 UWB TWR antenna [UWB_TWR]
 - ~24% for Ch9 UWB PDoA antennas [UWB2, UWB3, UWB4]
 - ~16% for 2.4GHz BLE array [Beam1~Beam8]; ~26% for 2.4GHz BLE slot directional antenna [Beam9]
 - ~23% for 2.4GHz BLE array [Omni]
- Peak gain
 - 6.4dBi for 2.4GHz, 6.3dBi for 5GHz, 9.3dBi for 6GHz Wi-Fi Tri-band antennas [TB1, TB2, TB3, TB4]
 - 7.6dBi for 5GHz Wi-Fi 5G antennas [5G1, 5G2, 5G3, 5G4]
 - 8.5dBi for 6GHz Wi-Fi 6G antennas [6G1, 6G2, 6G3, 6G4]
 - 5.8dBi for 2.4GHz, 6.3dBi for 5GHz, 8.2dBi for 6GHz Scanning antennas [SC1, SC2]
 - 6.6dBi for 2.4GHz Zigbee(Thread) antenna [Zigbee(Thread)]
 - 2.3dBi for L1, 4.6dBi for L5 GPS antenna [GPS]
 - 6.7dBi for Ch9 UWB TWR antenna [UWB_TWR]
 - 3.4dBi for Ch9 UWB PDoA antennas [UWB2, UWB3, UWB4]
 - 4.3dBi for 2.4GHz BLE array [Beam1~Beam8]; 3.7dBi for 2.4GHz BLE slot directional antenna [Beam9]
 - 0.2dBi for 2.4GHz BLE array [Omni]

Summary(2)

The summary of antenna performance are shown in below.

- 3 dB Beamwidth
 - 80°/84° on XZ/YZ plane for 2.4GHz, 71°/69° on XZ/YZ plane for 5GHz, 60°/59° on XZ/YZ plane for 6GHz Wi-Fi Tri-band antennas [TB1, TB2, TB3, TB4]
 - 63°/61° on XZ/YZ plane for 5GHz Wi-Fi 5G antennas [5G1, 5G2, 5G3, 5G4]
 - 57°/56° on XZ/YZ plane for 6GHz Wi-Fi 6G antennas [6G1, 6G2, 6G3, 6G4]
 - 100°/77° on XZ/YZ plane for 2.4GHz 81°/81° on XZ/YZ plane for 5GHz, 55°/68° on XZ/YZ plane for 6GHz Scanning antennas [SC1, SC2]
 - 80°/45° on XZ/YZ plane for 2.4GHz Zigbee(Thread) antenna [Zigbee(Thread)]
 - 88°/62° on XZ/YZ plane for Ch9 UWB TWR antenna [UWB_TWR]

Antenna Placement



Antenna Plate: 246x246mm

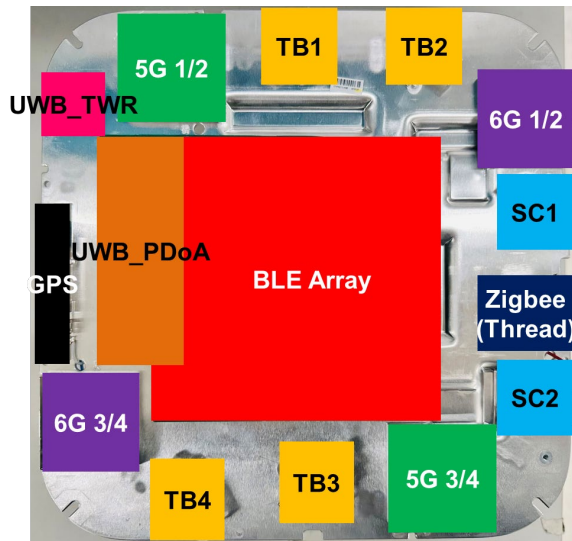
Radio	Antenna Type
TB(1-4)	Dipole
5G(1-4)	Patch
6G(1-4)	Patch
SC(1-2)	Dipole
GPS	PIFA
UWB-TWR	Patch
UWB-PDoA	Patch
Zigbee(Thread)	Dipole
BLE [Beam1~Beam8/Omni]	PIFA
BLE [Beam9]	Slot

UWB_TWR	Peak Gain	Position of Peak Gain (θ , φ)
TWR	6.7 dBi	$\theta = 9^\circ$, $\varphi = 177^\circ$

Zigbee(Thread)	Peak Gain	Position of Peak Gain (θ , φ)
Zigbee(Thread)	6.6 dBi	$\theta = 9^\circ$, $\varphi = 159^\circ$

BLE Array	Peak Gain	Position of Peak Gain (θ , φ)
BLE Array (Beam5)	4.3 dBi	$\theta = 53^\circ$, $\varphi = 270^\circ$

Wi-Fi Tri-band



■ Maximum VSWR

- 2.0:1 on 2.4GHz / 2.0:1 on 5/6GHz

■ Minimum Isolation

- 23.2dB on 2.4GHz / 32.1dB on 5/6GHz

■ Average Efficiency

- ~65% on 2.4GHz / ~60% on 5GHz / ~63% on 6GHz

■ Peak Gain

- 6.4dBi on 2.4GHz / 6.3dBi on 5GHz / 9.3dBi on 6GHz

■ Cable Length

TB1 : 87mm

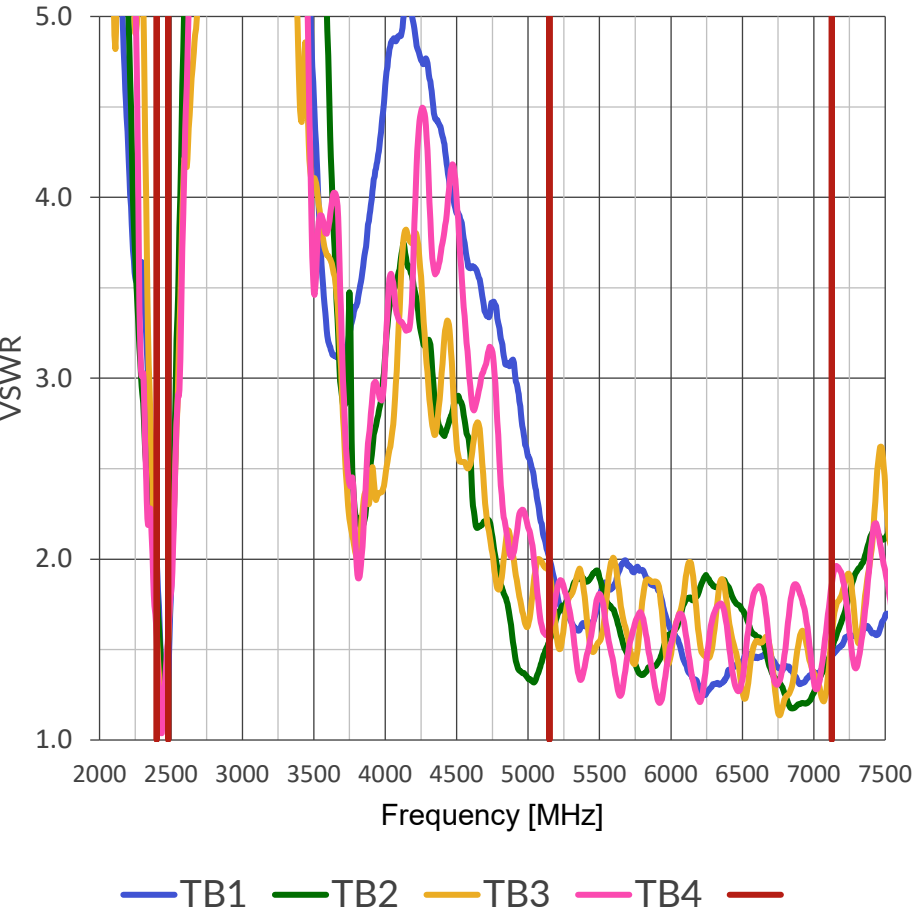
TB2 : 95mm

TB3 : 389mm

TB4 : 381mm

VSWR

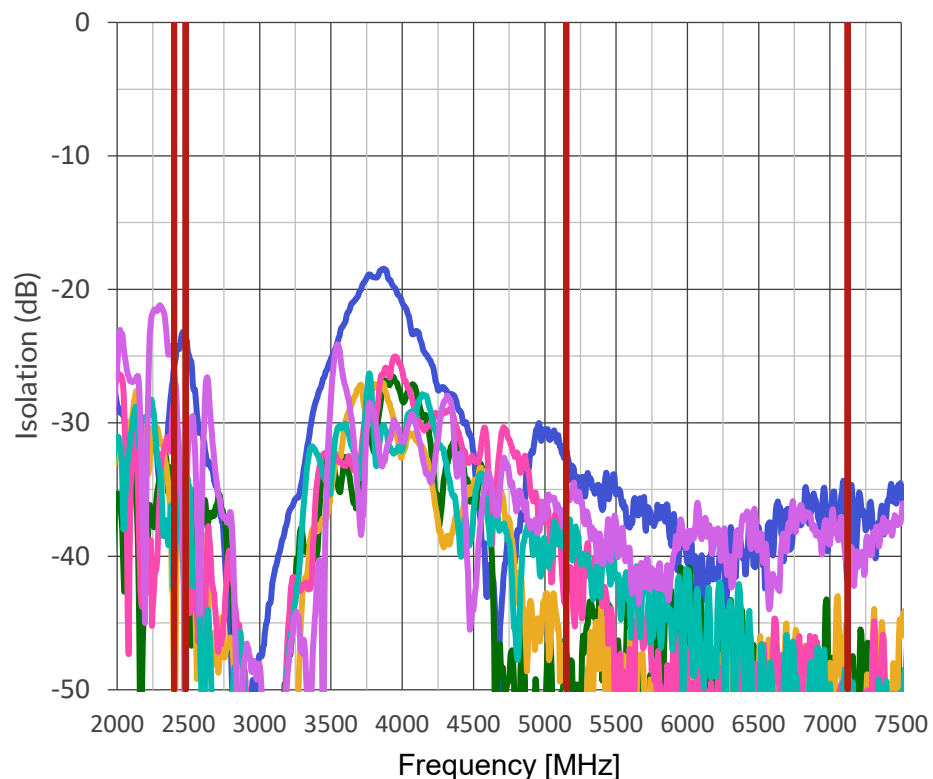
Wi-Fi Tri-band



2.4GHz	Max	Mean	Min
TB1	2.0	1.4	1.1
TB2	1.9	1.5	1.2
TB3	1.6	1.3	1.2
TB4	1.6	1.3	1.0
Summary	2.0	1.4	1.0

5/6GHz	Max	Mean	Min
TB1	2.0	1.6	1.2
TB2	1.9	1.6	1.2
TB3	2.0	1.6	1.1
TB4	1.9	1.6	1.2
Summary	2.0	1.6	1.1

Isolation Wi-Fi Tri-band

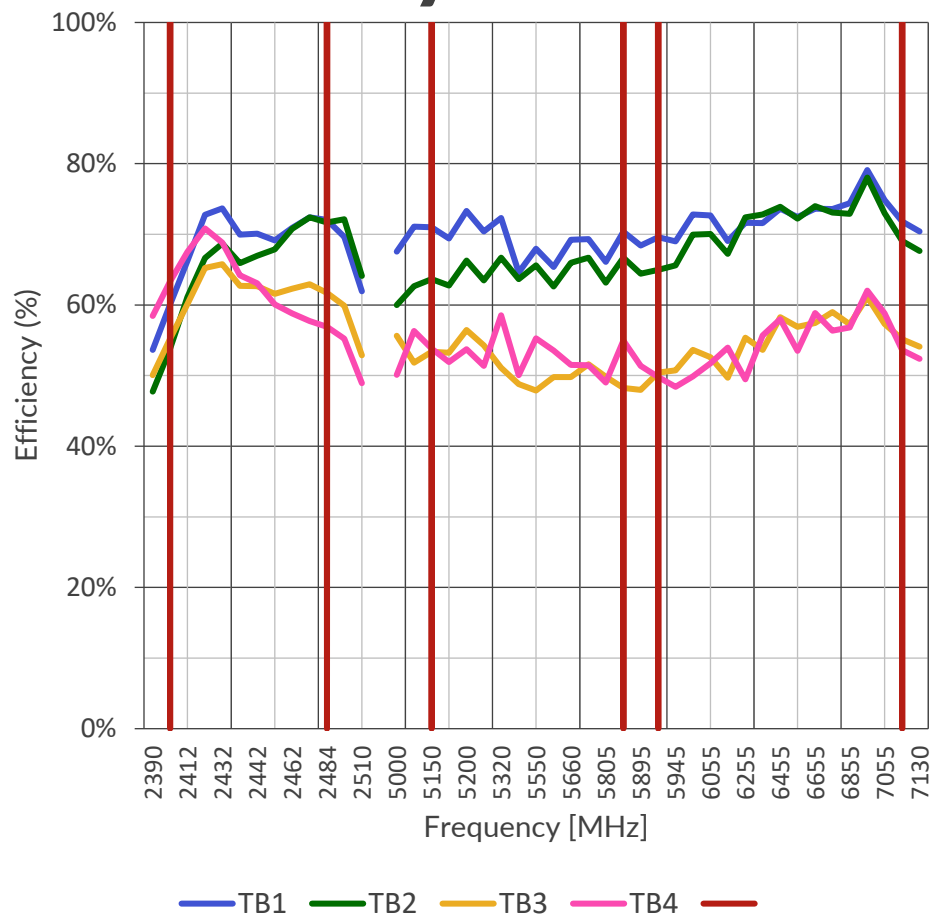


— TB1_TB2
 — TB1_TB3
 — TB1_TB4
 — TB2_TB3
 — TB2_TB4
 — TB3_TB4
 —

2.4GHz	Max	Mean	Min
TB1_TB2	-23.2	-24.2	-25.8
TB1_TB3	-31.8	-34.5	-36.7
TB1_TB4	-37.7	-41.4	-54.2
TB2_TB3	-28.7	-34.5	-40.3
TB2_TB4	-33.5	-37.8	-42.2
TB3_TB4	-26.0	-35.2	-57.5
Summary	-23.2	-34.6	-57.5

5/6GHz	Max	Mean	Min
TB1_TB2	-32.1	-37.6	-45.4
TB1_TB3	-40.8	-50.1	-79.0
TB1_TB4	-43.0	-51.9	-69.5
TB2_TB3	-39.0	-49.1	-69.7
TB2_TB4	-37.1	-46.8	-66.3
TB3_TB4	-34.5	-38.9	-44.0
Summary	-32.1	-45.8	-79.0

Efficiency Wi-Fi Tri-band



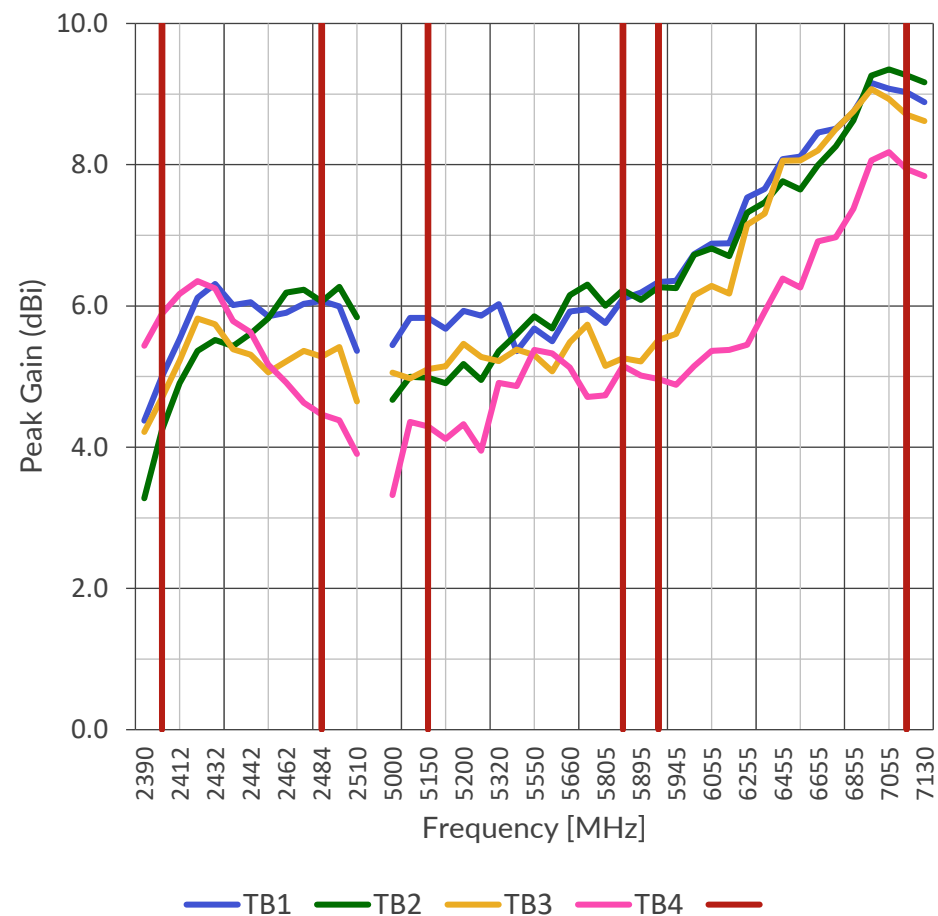
2.4GHz	Max	Mean	Min
TB1	74 %	70 %	60 %
TB2	72 %	67 %	54 %
TB3	66 %	62 %	55 %
TB4	71 %	63 %	57 %
Summary	74 %	65 %	54 %

5GHz	Max	Mean	Min
TB1	73 %	69 %	65 %
TB2	67 %	65 %	63 %
TB3	56 %	51 %	48 %
TB4	59 %	53 %	49 %
Summary	73 %	60 %	48 %

6GHz	Max	Mean	Min
TB1	79 %	73 %	69 %
TB2	78 %	71 %	65 %
TB3	61 %	55 %	50 %
TB4	62 %	54 %	48 %
Summary	79 %	63 %	48 %

- Cable Length
- TB1 : 87mm
- TB2 : 95mm
- TB3 : 389mm
- TB4 : 381mm

Peak Gain Wi-Fi Tri-band



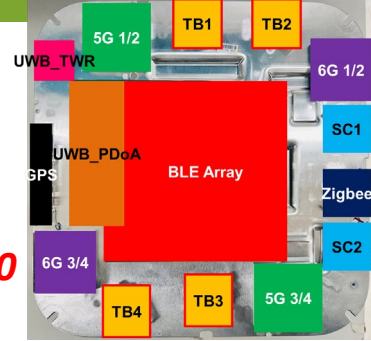
2.4GHz	Max	Mean	Min
TB1	6.3 dBi	5.9 dBi	5.0 dBi
TB2	6.2 dBi	5.5 dBi	4.2 dBi
TB3	5.8 dBi	5.3 dBi	4.7 dBi
TB4	6.4 dBi	5.5 dBi	4.5 dBi
Summary	6.4 dBi	5.6 dBi	4.2 dBi

5GHz	Max	Mean	Min
TB1	6.1 dBi	5.8 dBi	5.4 dBi
TB2	6.3 dBi	5.6 dBi	4.9 dBi
TB3	5.7 dBi	5.3 dBi	5.1 dBi
TB4	5.4 dBi	4.7 dBi	4.0 dBi
Summary	6.3 dBi	5.4 dBi	4.0 dBi

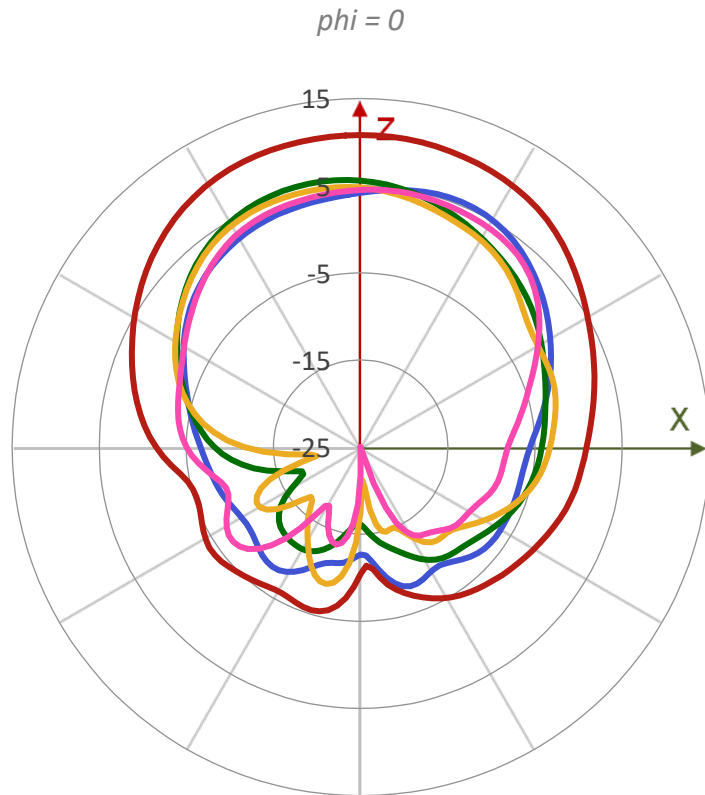
6GHz	Max	Mean	Min
TB1	9.2 dBi	7.8 dBi	6.3 dBi
TB2	9.3 dBi	7.7 dBi	6.3 dBi
TB3	9.1 dBi	7.5 dBi	5.5 dBi
TB4	8.2 dBi	6.3 dBi	4.9 dBi
Summary	9.3 dBi	7.3 dBi	4.9 dBi

- Cable Length
- TB1 : 87mm
- TB2 : 95mm
- TB3 : 389mm
- TB4 : 381mm

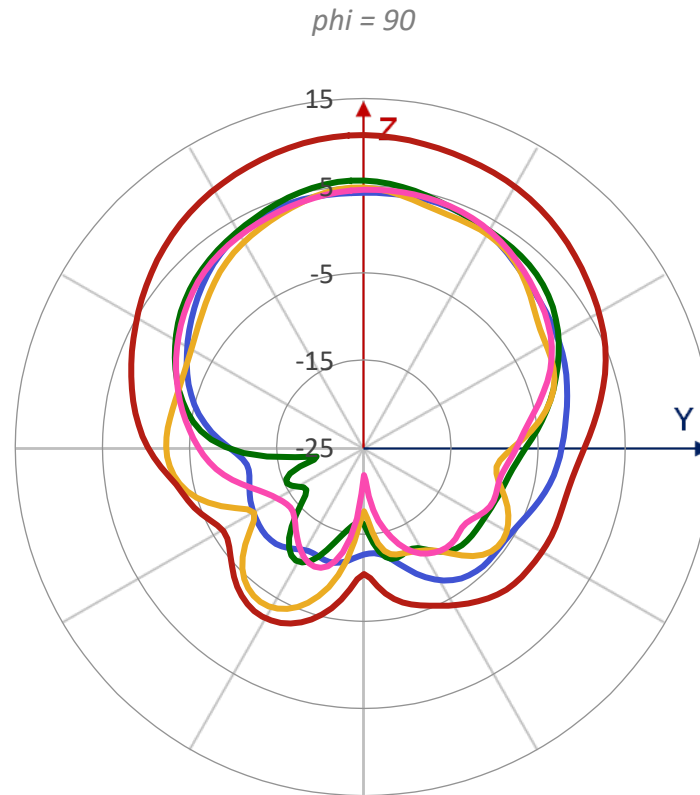
Realized Gain Pattern Wi-Fi Tri-band @2.4G for Gtotal



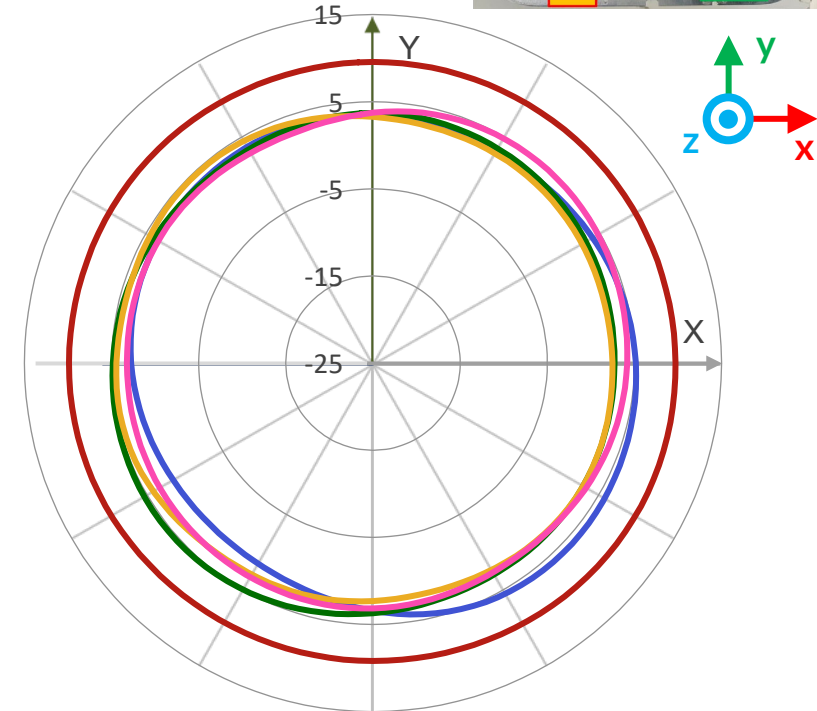
theta = 30



— TB1 — TB2 — TB3
— TB4 — Composite



— TB1 — TB2 — TB3
— TB4 — Composite

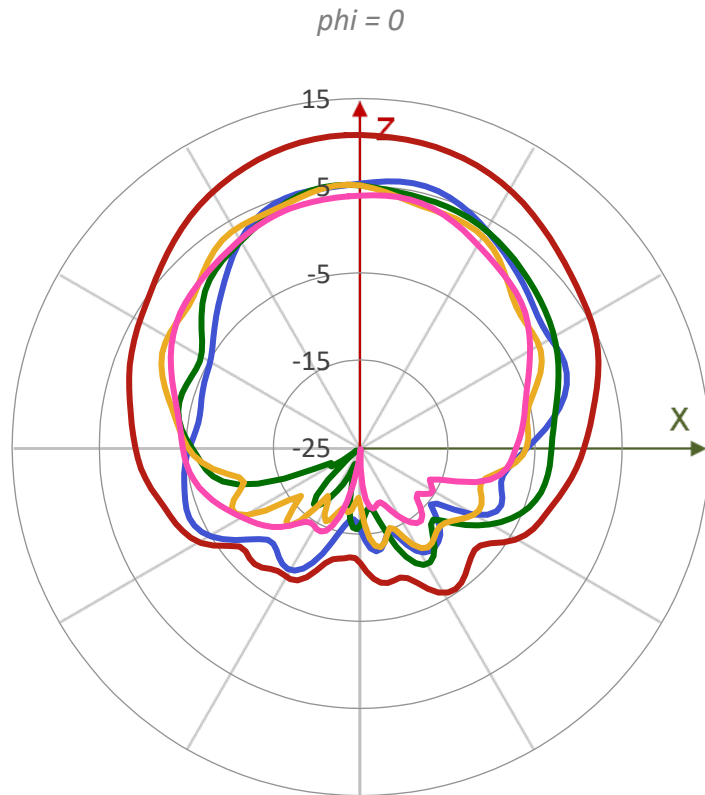
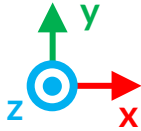


— TB1 — TB2 — TB3
— TB4 — Composite

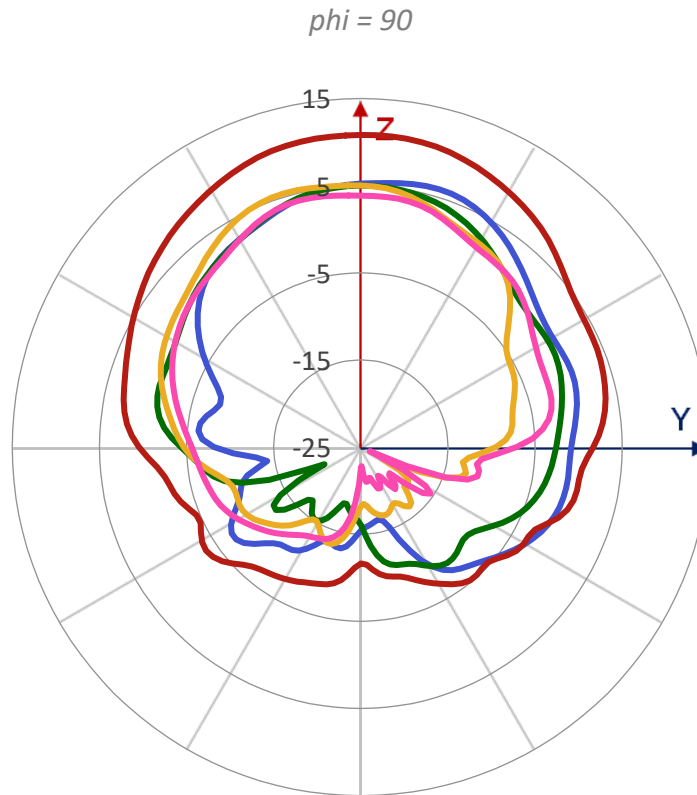
Realized Gain Pattern Wi-Fi Tri-band @5G for Gtotal



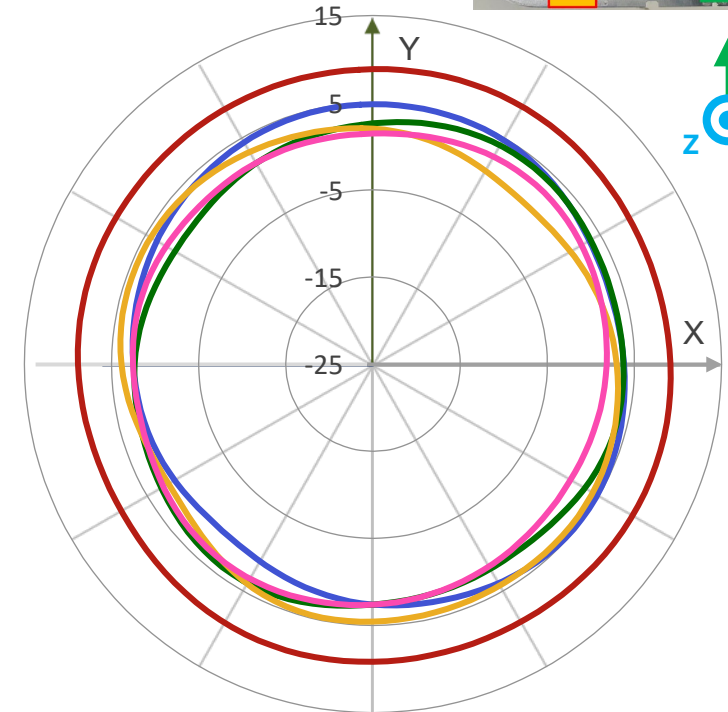
theta = 30



— TB1 — TB2 — TB3
— TB4 — Composite

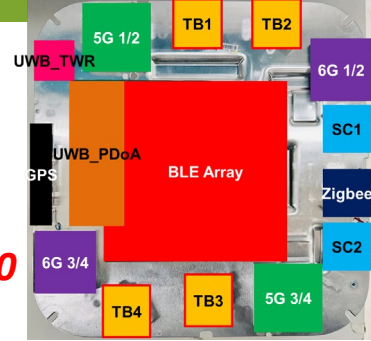


— TB1 — TB2 — TB3
— TB4 — Composite

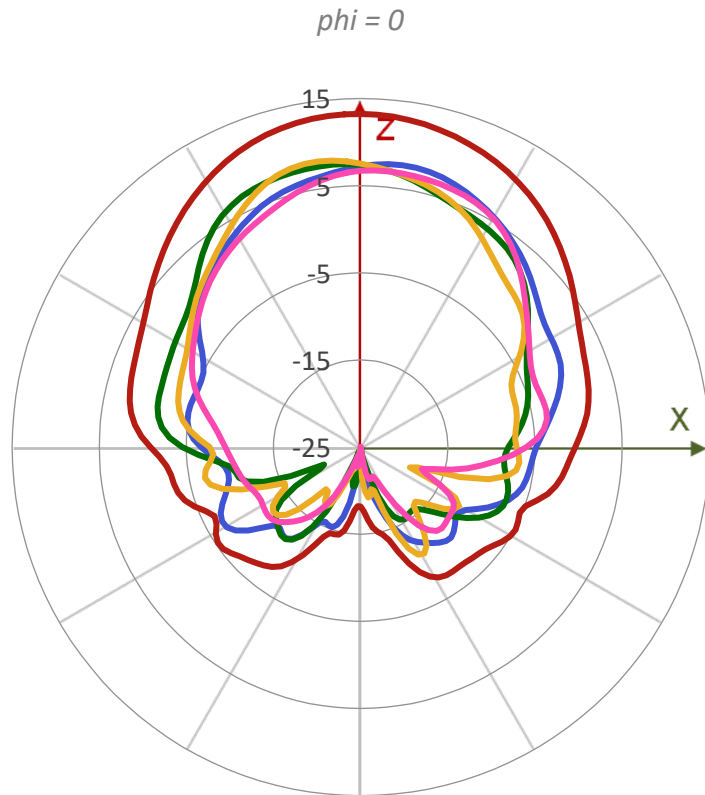
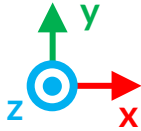


— TB1 — TB2 — TB3
— TB4 — Composite

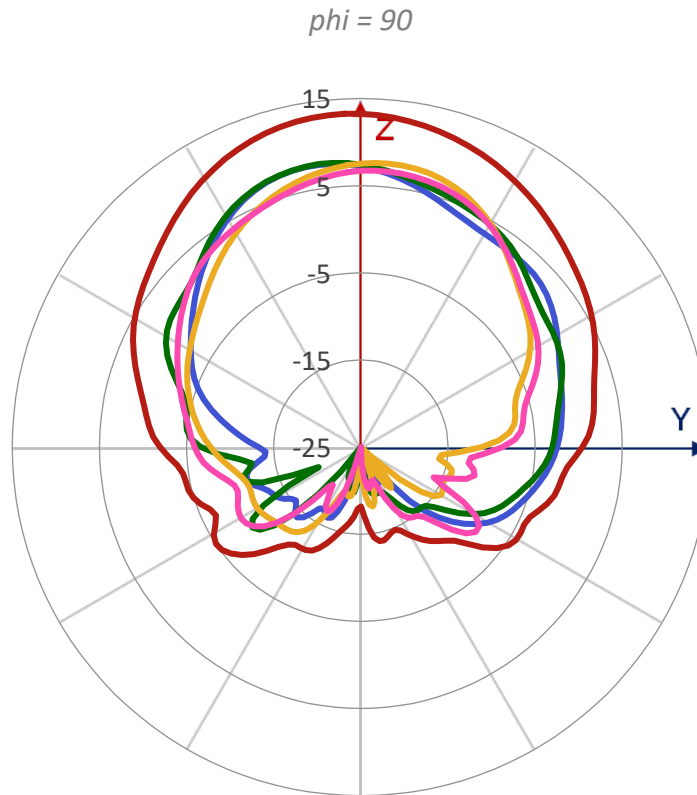
Realized Gain Pattern Wi-Fi Tri-band @6G for Gtotal



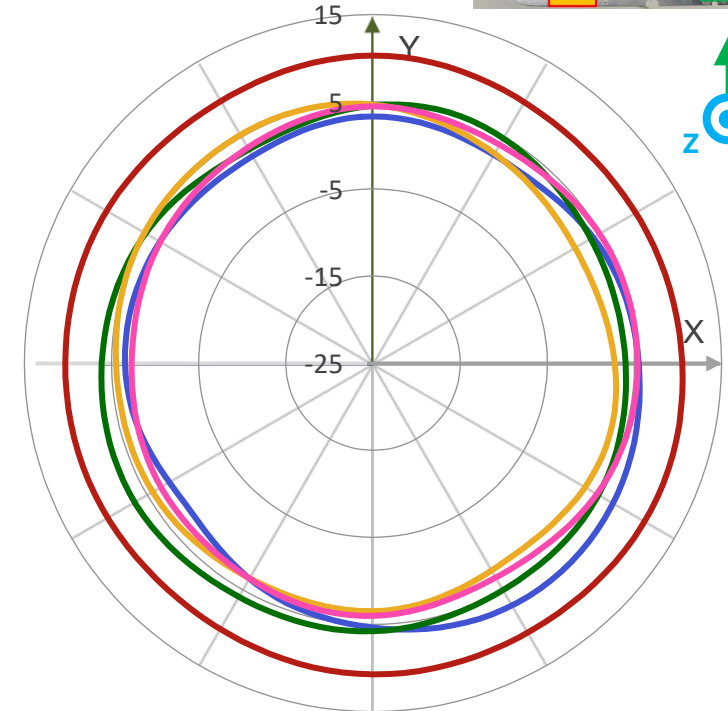
theta = 30



— TB1 — TB2 — TB3
— TB4 — Composite

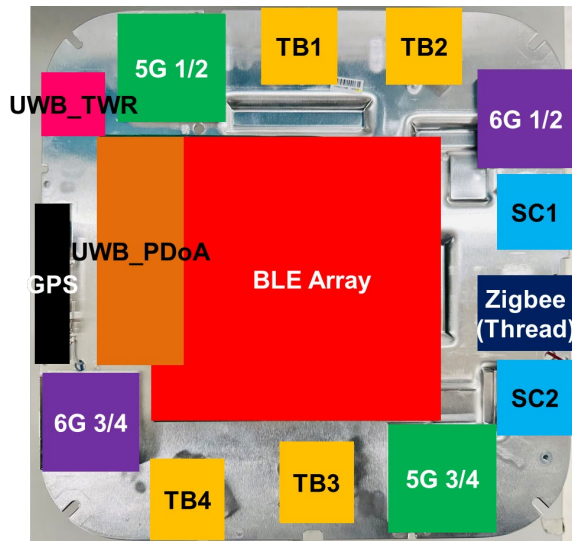


— TB1 — TB2 — TB3
— TB4 — Composite



— TB1 — TB2 — TB3
— TB4 — Composite

Wi-Fi 5G



■ Maximum VSWR

- 2.0:1 on 5GHz

■ Minimum Isolation

- 20.0dB on 5GHz

■ Average Efficiency

- ~60% on 5GHz

■ Peak Gain

- 7.6dBi on 5GHz

■ Cable Length

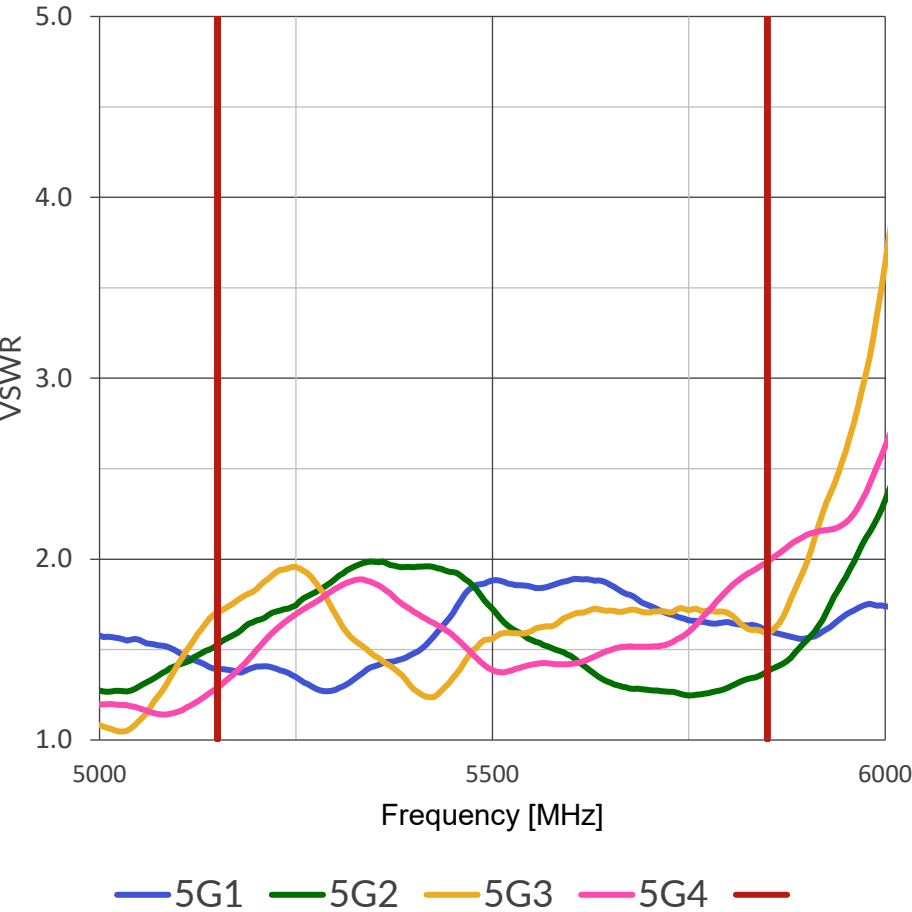
5G1 : 167mm

5G2 : 163mm

5G3 : 263mm

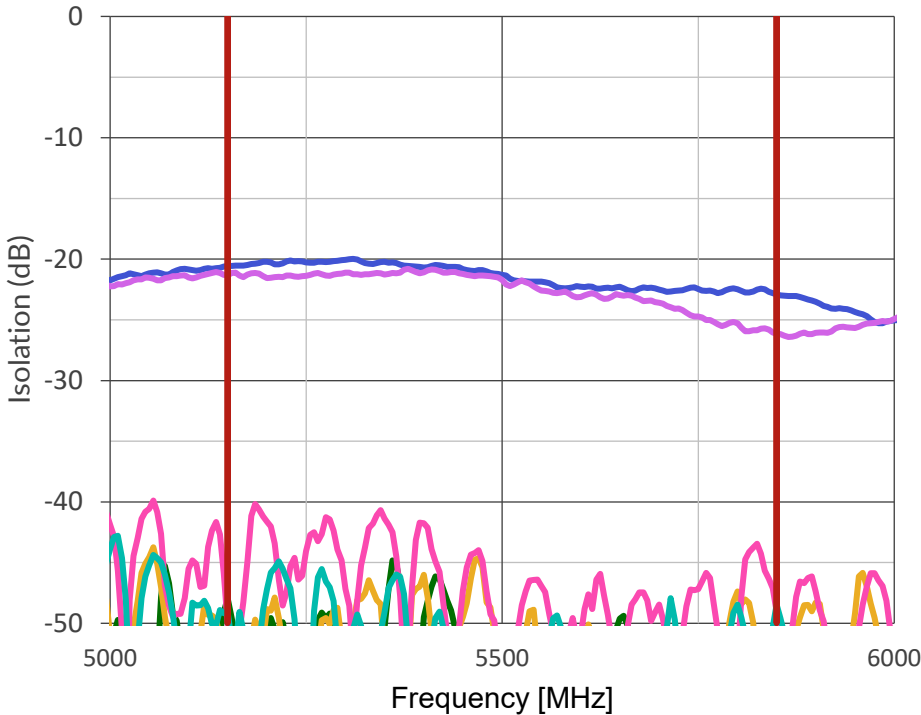
5G4 : 261mm

VSWR Wi-Fi 5G



5GHz	Max	Mean	Min
5G1	1.9	1.6	1.3
5G2	2.0	1.6	1.2
5G3	2.0	1.6	1.2
5G4	2.0	1.6	1.3
Summary	2.0	1.6	1.2

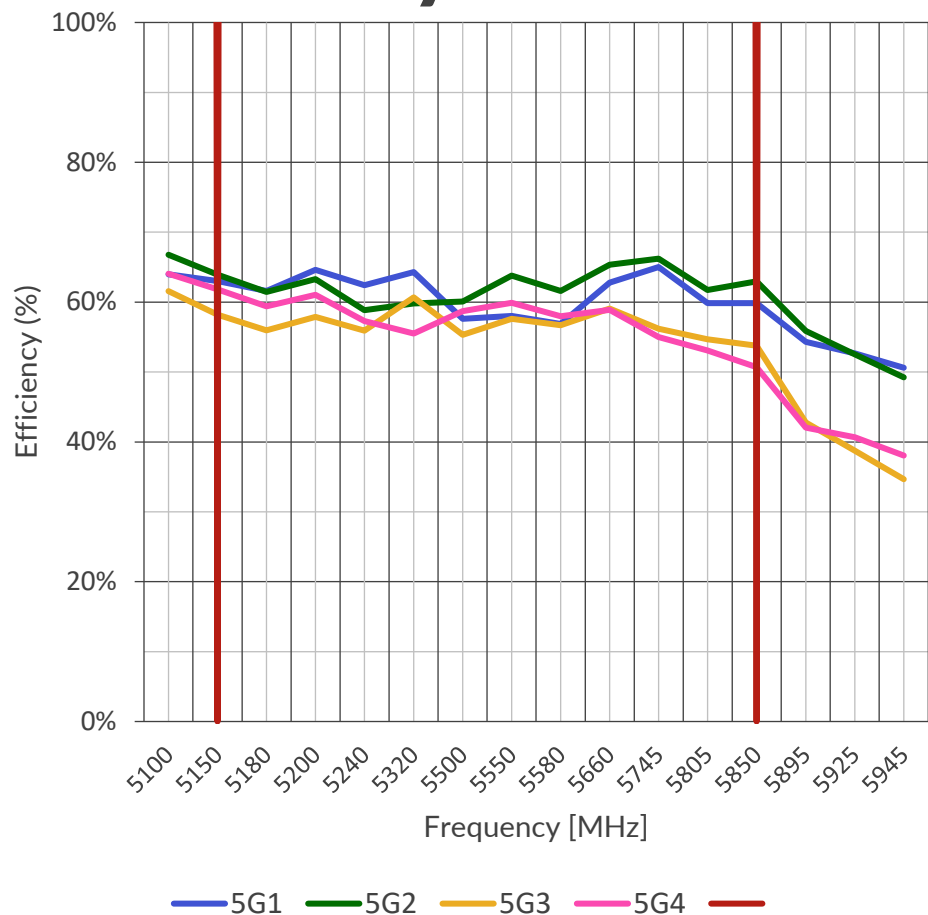
Isolation Wi-Fi 5G



5GHz	Max	Mean	Min
5G1_5G2	-20.0	-21.4	-22.9
5G1_5G3	-44.8	-55.0	-71.3
5G1_5G4	-44.6	-53.8	-72.4
5G2_5G3	-40.2	-47.7	-62.8
5G2_5G4	-44.9	-53.9	-71.1
5G3_5G4	-20.8	-22.5	-26.1
Summary	-20.0	-42.4	-72.4

— 5G1_5G2 — 5G1_5G3 — 5G1_5G4
— 5G2_5G3 — 5G2_5G4 — 5G3_5G4
—

Efficiency Wi-Fi 5G



5GHz	Max	Mean	Min
5G1	65 %	61 %	57 %
5G2	66 %	62 %	59 %
5G3	61 %	57 %	54 %
5G4	62 %	57 %	51 %
Summary	66 %	60 %	51 %

■ Cable Length

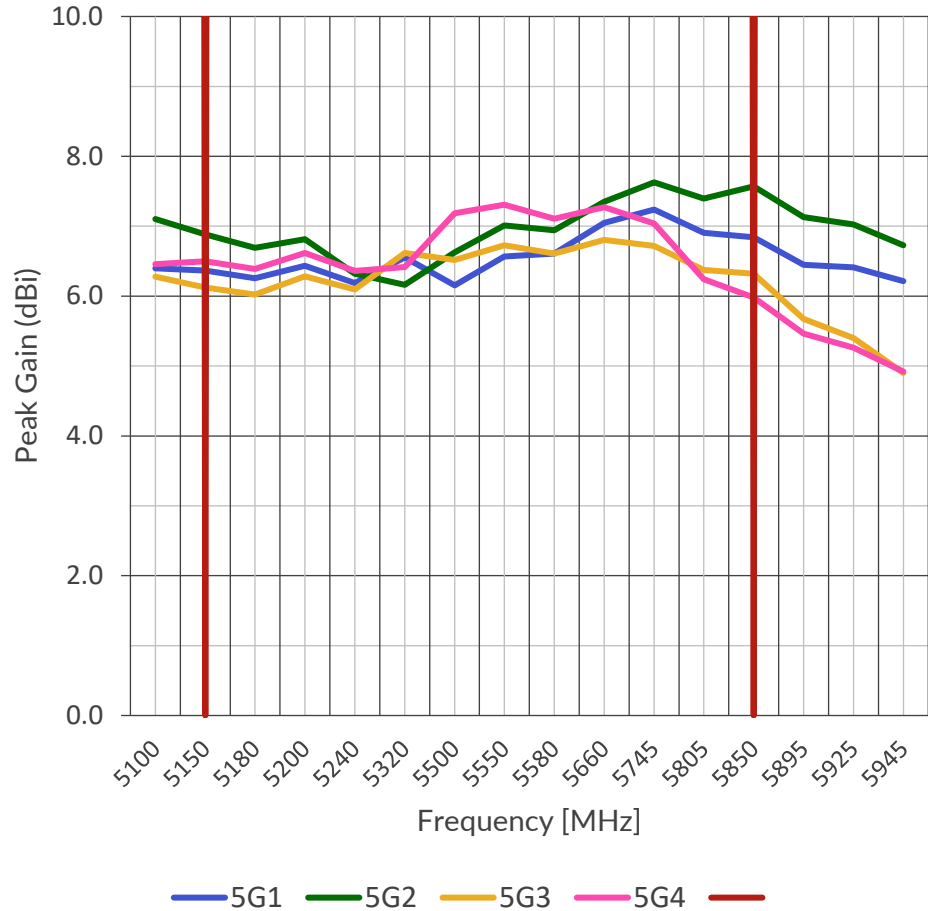
5G1 : 167mm

5G2 : 163mm

5G3 : 263mm

5G4 : 261mm

Peak Gain Wi-Fi 5G



5GHz	Max	Mean	Min
5G1	7.2 dBi	6.6 dBi	6.2 dBi
5G2	7.6 dBi	6.9 dBi	6.2 dBi
5G3	6.8 dBi	6.4 dBi	6.0 dBi
5G4	7.3 dBi	6.7 dBi	6.0 dBi
Summary	7.6 dBi	6.7 dBi	6.0 dBi

■ Cable Length

5G1 : 167mm

5G2 : 163mm

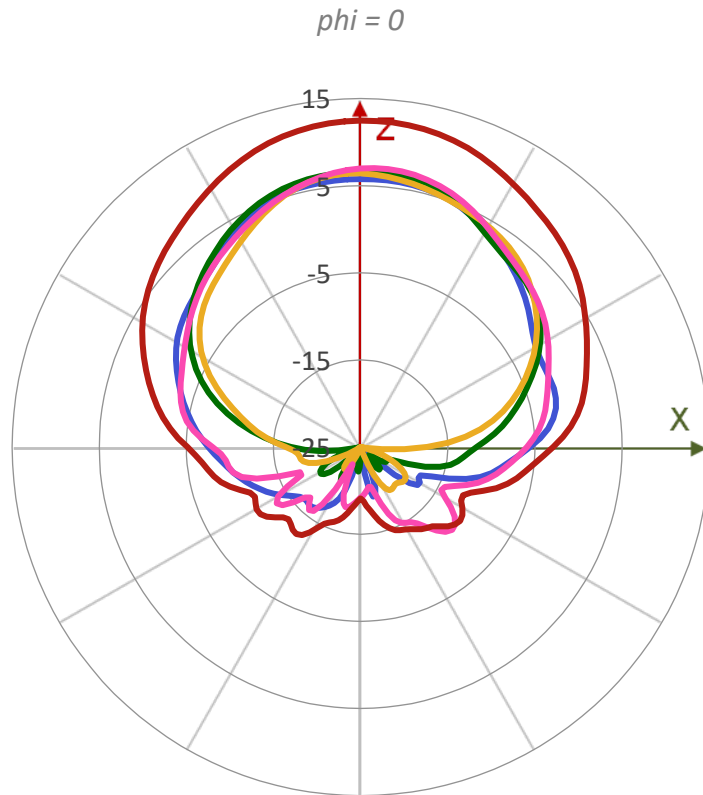
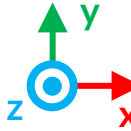
5G3 : 263mm

5G4 : 261mm

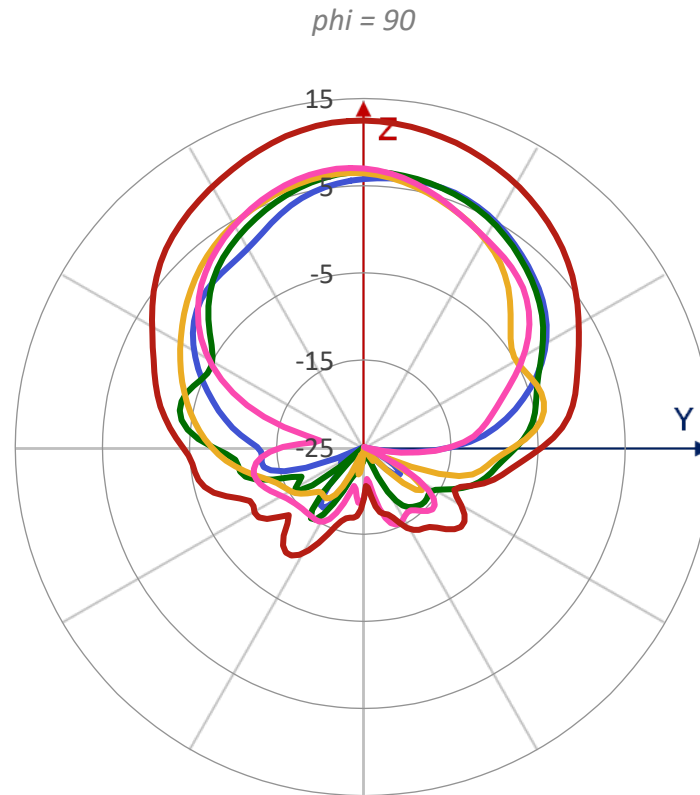
Realized Gain Pattern Wi-Fi 5G @5G for Gtotal



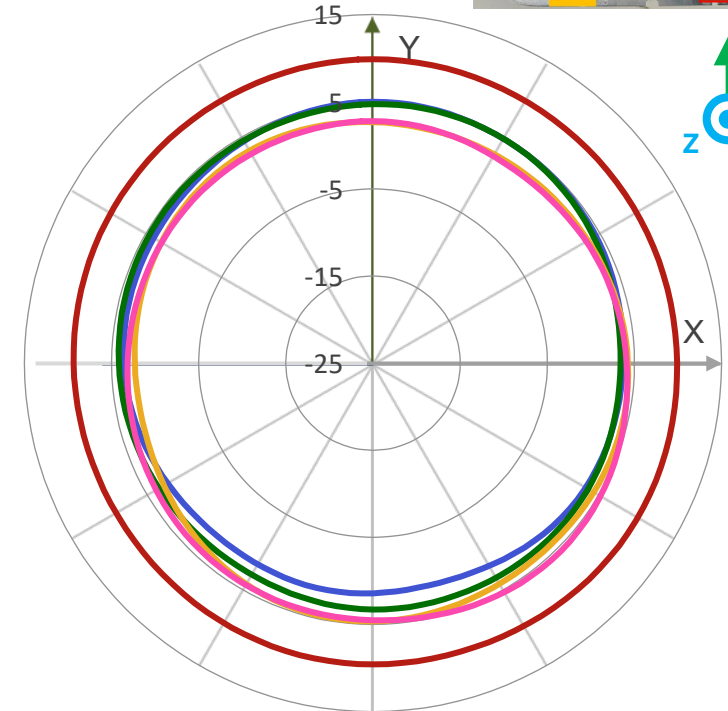
theta = 30



— 5G1 — 5G2 — 5G3
— 5G4 — Composite

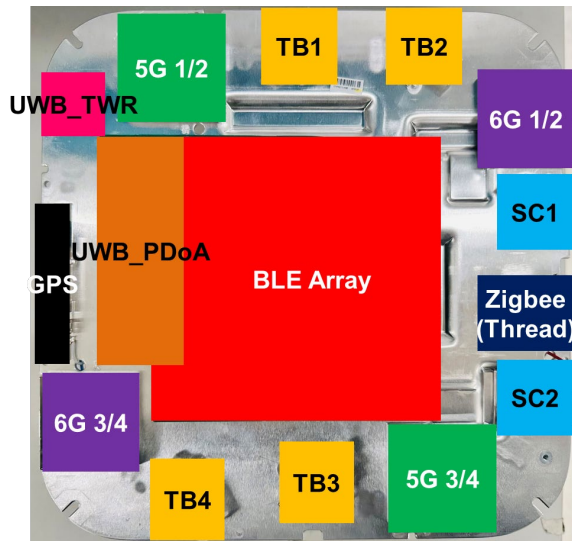


— 5G1 — 5G2 — 5G3
— 5G4 — Composite



— 5G1 — 5G2 — 5G3
— 5G4 — Composite

Wi-Fi 6G



■ Maximum VSWR

- 2.0:1 on 6GHz

■ Minimum Isolation

- 20.1dB on 6GHz

■ Average Efficiency

- ~60% on 6GHz

■ Peak Gain

- 8.5dBi on 6GHz

■ Cable Length

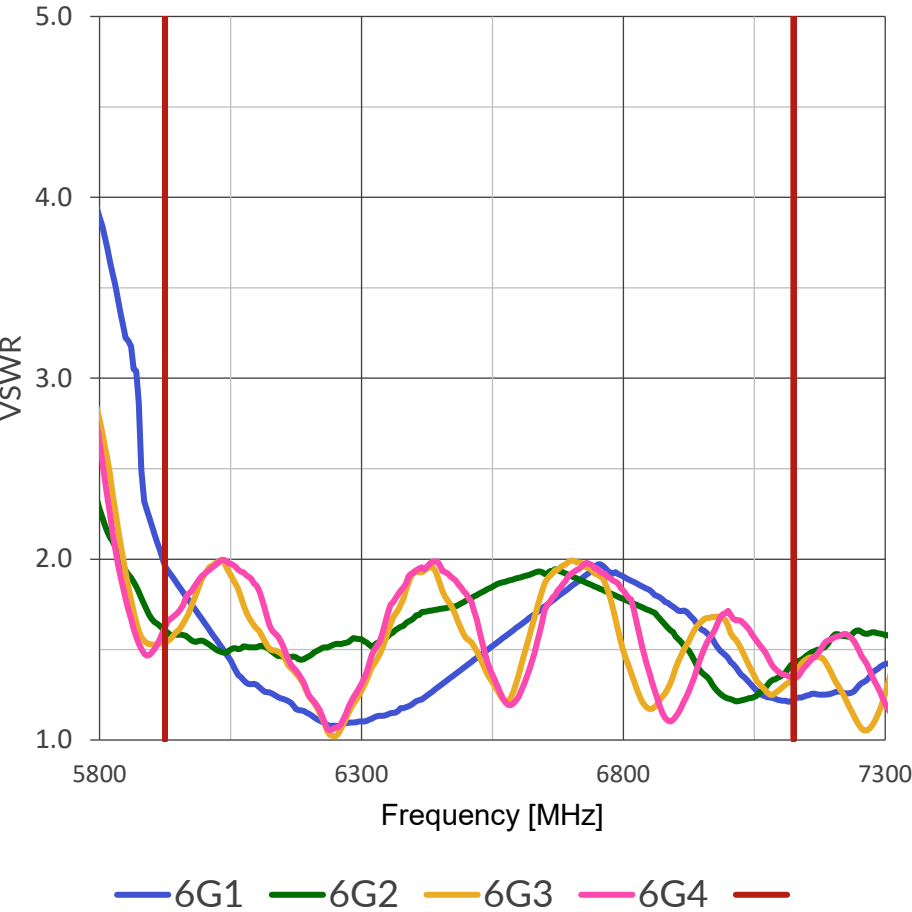
6G1 : 106mm

6G2 : 93mm

6G3 : 347mm

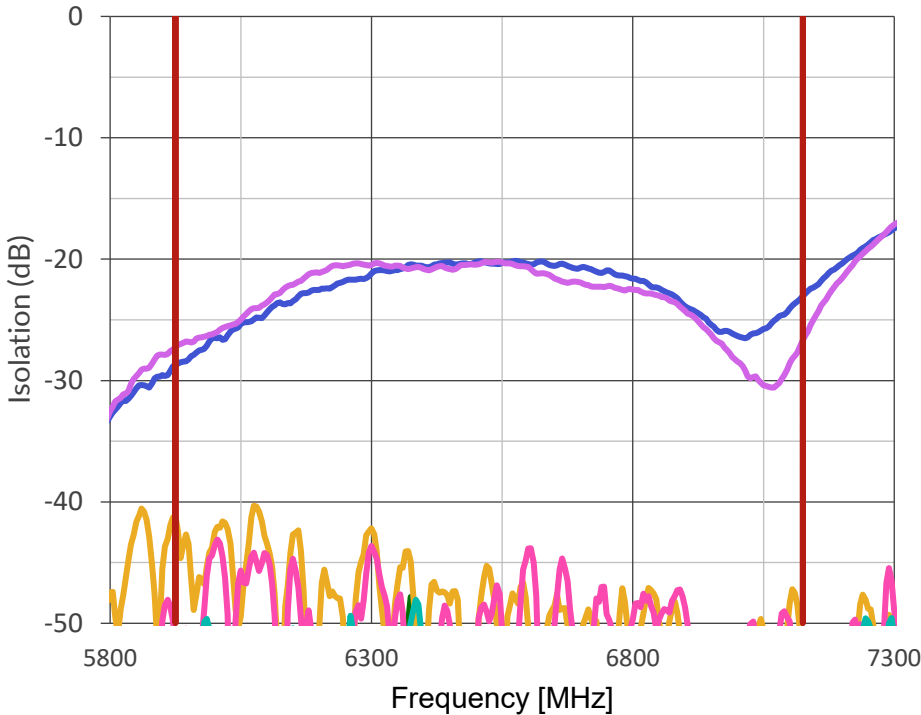
6G4 : 331mm

VSWR Wi-Fi 6G



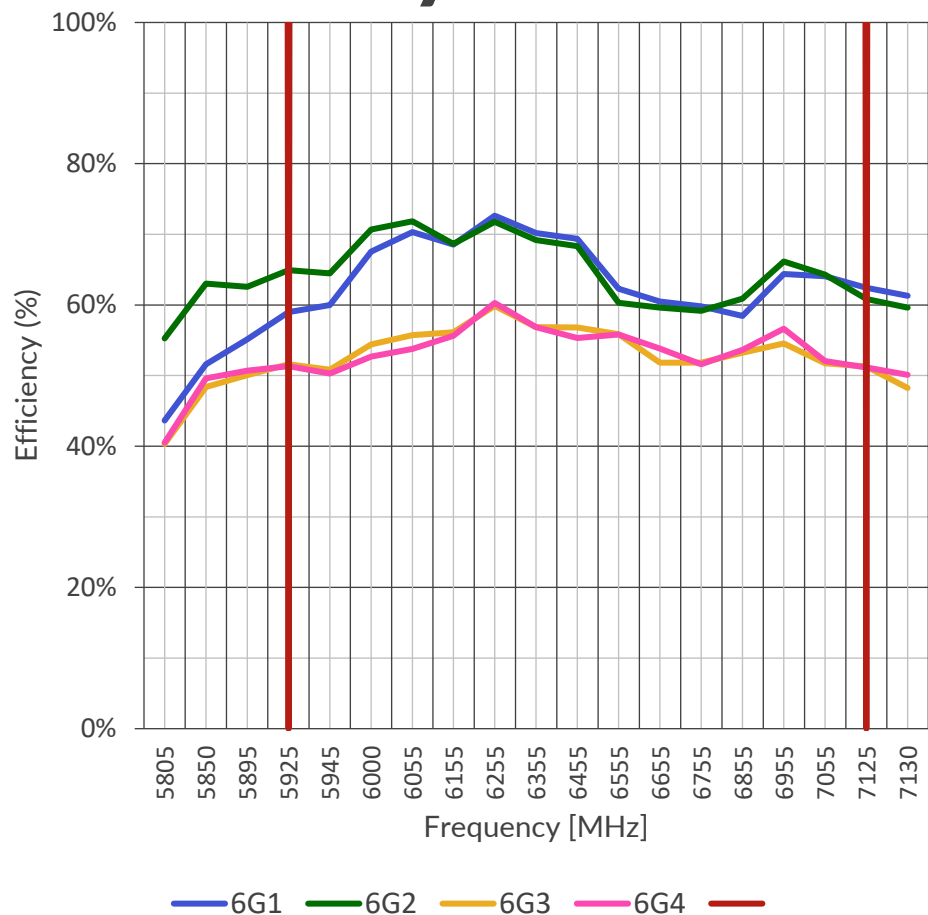
6GHz	Max	Mean	Min
6G1	2.0	1.5	1.1
6G2	1.9	1.6	1.2
6G3	2.0	1.6	1.0
6G4	2.0	1.6	1.1
Summary	2.0	1.6	1.0

Isolation Wi-Fi 6G



6GHz	Max	Mean	Min
6G1_6G2	-20.1	-22.8	-28.7
6G1_6G3	-47.8	-58.9	-86.9
6G1_6G4	-40.3	-50.2	-67.1
6G2_6G3	-43.1	-52.2	-82.4
6G2_6G4	-48.1	-57.1	-83.0
6G3_6G4	-20.2	-23.2	-30.6
Summary	-20.1	-44.1	-86.9

Efficiency Wi-Fi 6G



6GHz	Max	Mean	Min
6G1	73 %	65 %	58 %
6G2	72 %	65 %	59 %
6G3	60 %	54 %	51 %
6G4	60 %	54 %	50 %
Summary	73 %	60 %	50 %

■ Cable Length

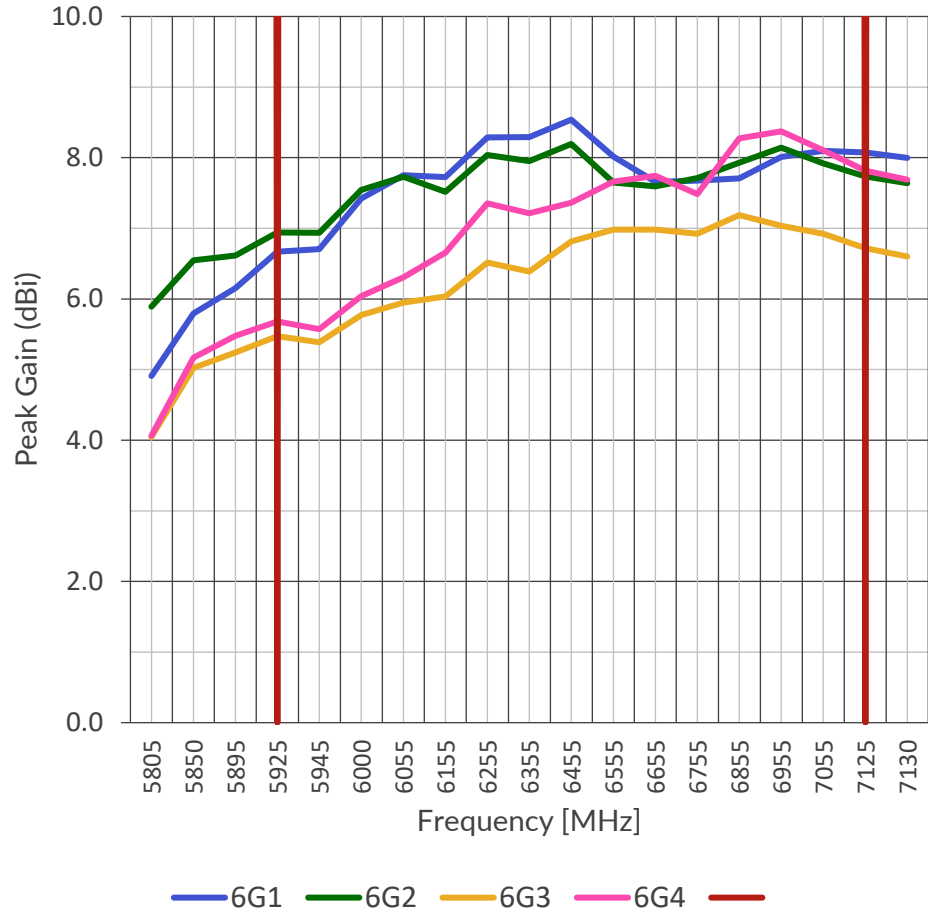
6G1 : 106mm

6G2 : 93mm

6G3 : 347mm

6G4 : 331mm

Peak Gain Wi-Fi 6G



6GHz	Max	Mean	Min
6G1	8.5 dBi	7.8 dBi	6.7 dBi
6G2	8.2 dBi	7.7 dBi	6.9 dBi
6G3	7.2 dBi	6.5 dBi	5.4 dBi
6G4	8.4 dBi	7.2 dBi	5.6 dBi
Summary	8.5 dBi	7.3 dBi	5.4 dBi

■ Cable Length

6G1 : 106mm

6G2 : 93mm

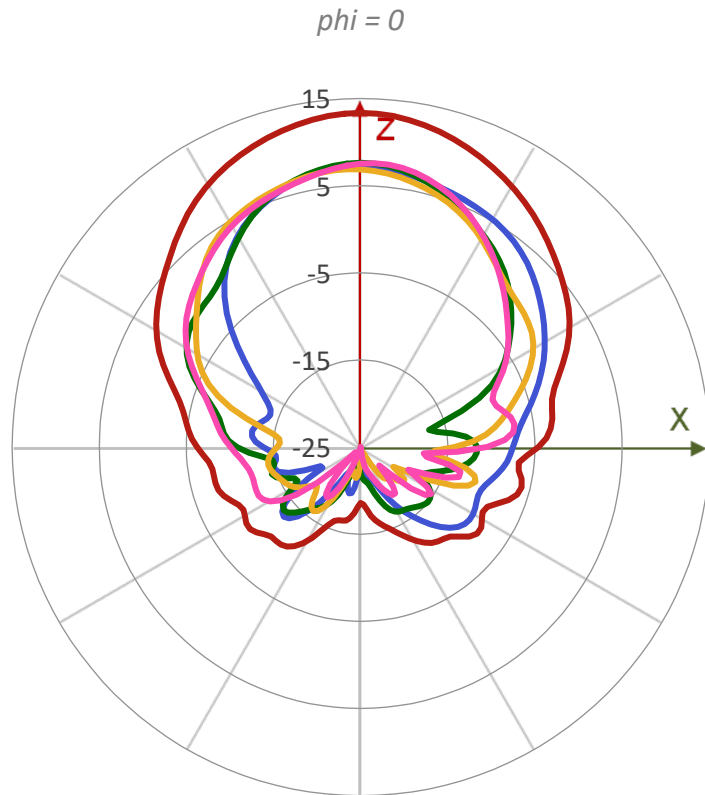
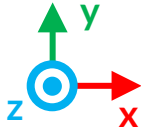
6G3 : 347mm

6G4 : 331mm

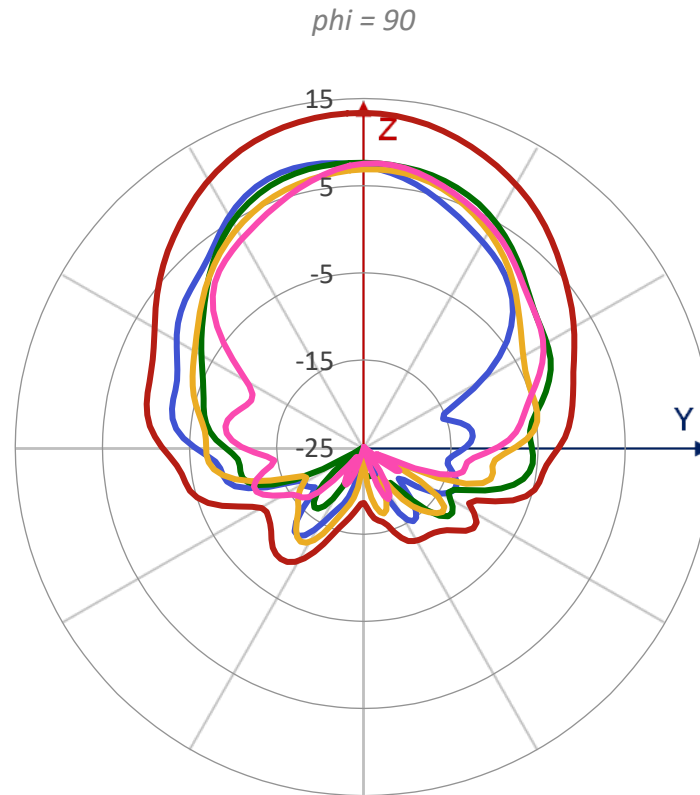
Realized Gain Pattern Wi-Fi 6G @6G for Gtotal



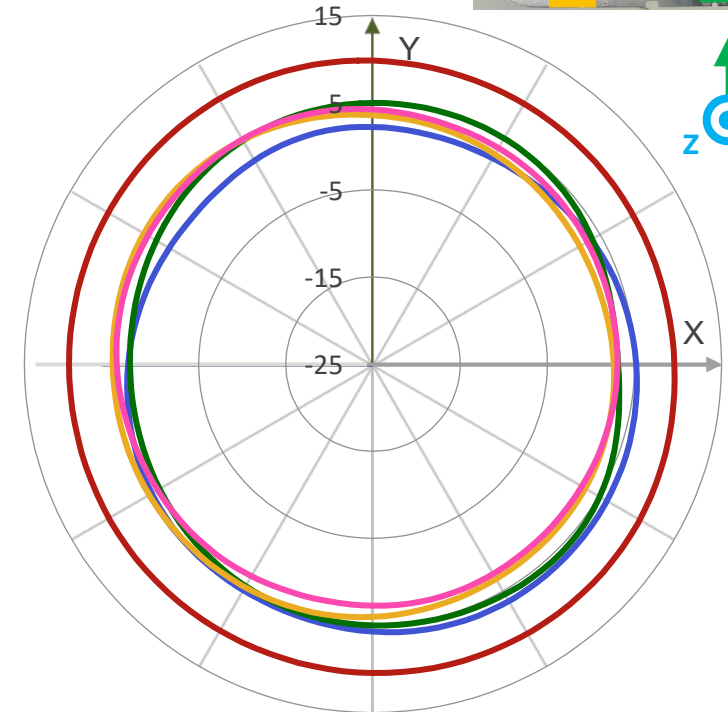
theta = 30



— 6G1 — 6G2 — 6G3
— 6G4 — Composite

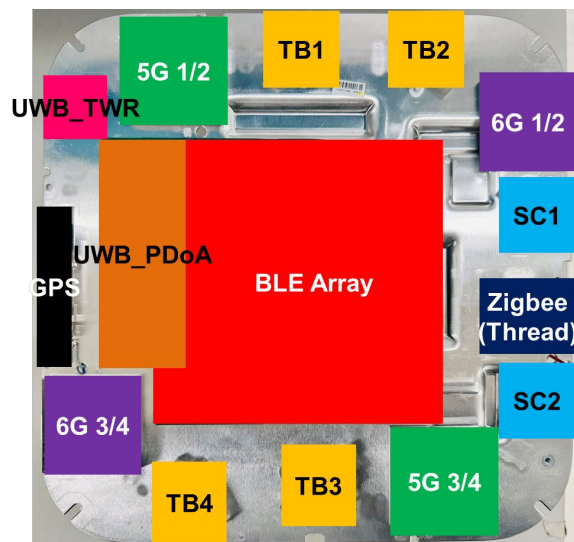


— 6G1 — 6G2 — 6G3
— 6G4 — Composite



— 6G1 — 6G2 — 6G3
— 6G4 — Composite

Scanning Radio



■ Maximum VSWR

- 2.0:1 on 2.4GHz / 2.0:1 on 5/6GHz

■ Minimum Isolation

- 17.2dB on 2.4GHz / 36.7dB on 5/6GHz

■ Average Efficiency

- ~64% on 2.4GHz / ~65% on 5GHz / ~68% on 6GHz

■ Peak Gain

- 5.8dBi on 2.4GHz / 6.3dBi on 5GHz / 8.2dBi on 6GHz

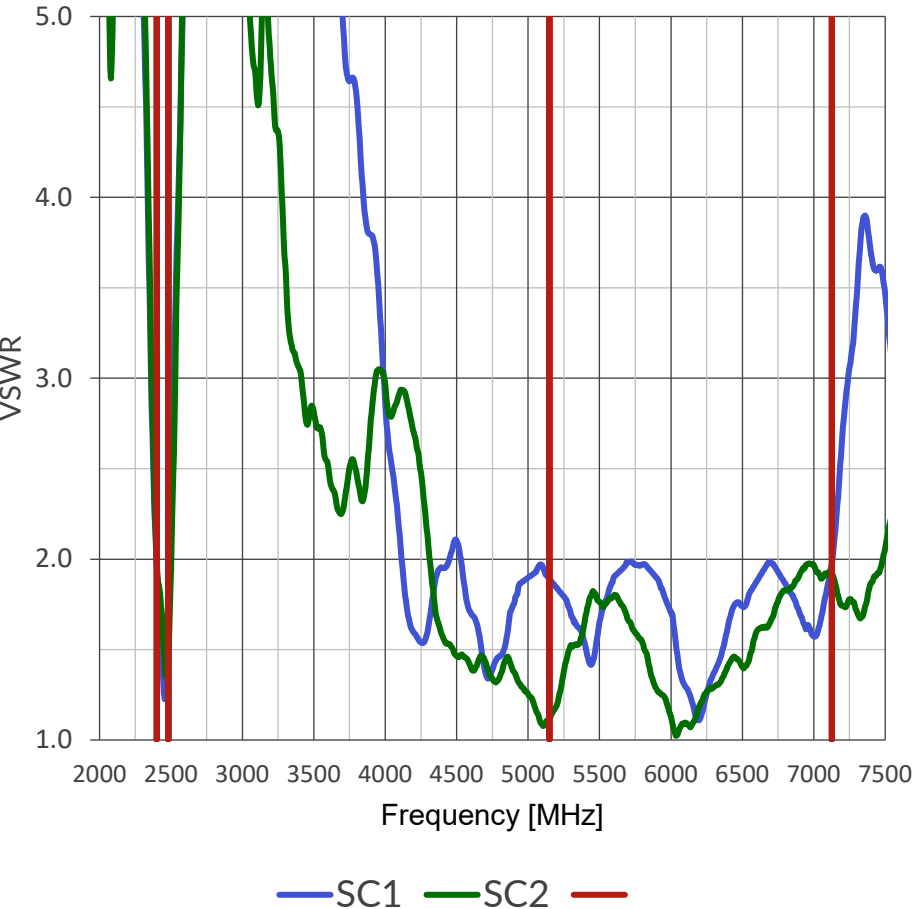
■ Cable Length

SC1 : 141mm

SC2 : 91mm

VSWR

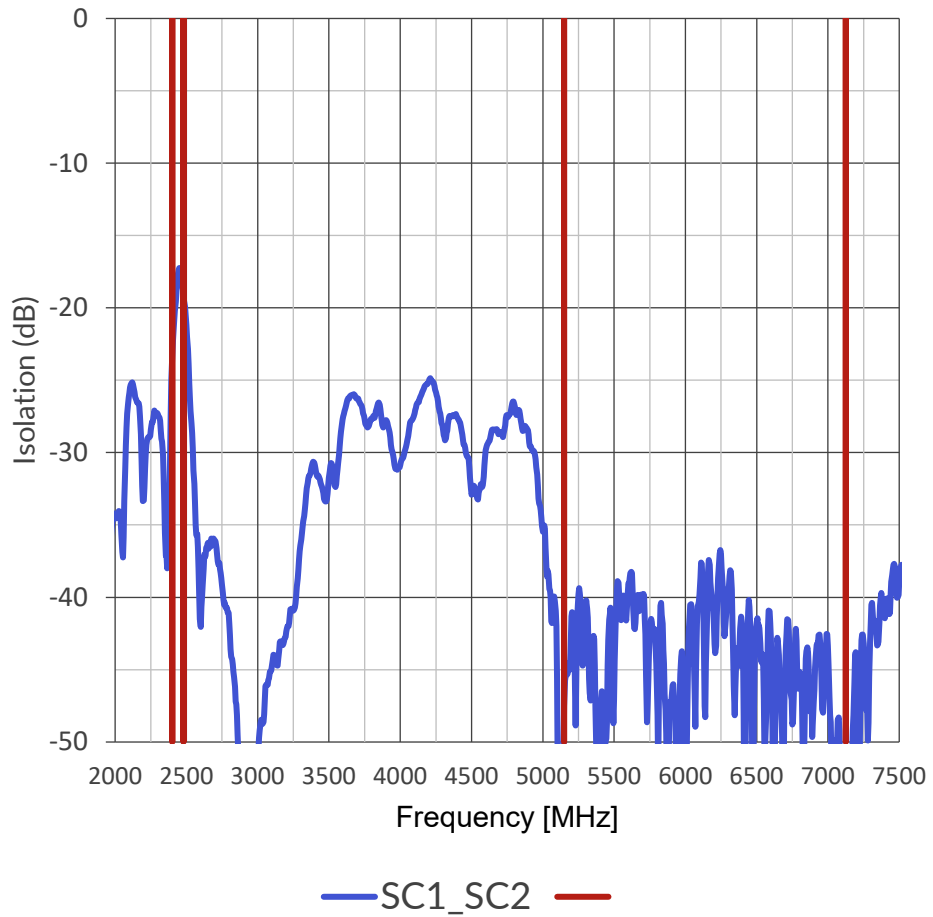
Scanning Radio



2.4GHz	Max	Mean	Min
SC1	2.0	1.6	1.2
SC2	2.0	1.6	1.3
Summary	2.0	1.6	1.2

5/6GHz	Max	Mean	Min
SC1	2.0	1.7	1.1
SC2	2.0	1.5	1.0
Summary	2.0	1.6	1.0

Isolation Scanning Radio

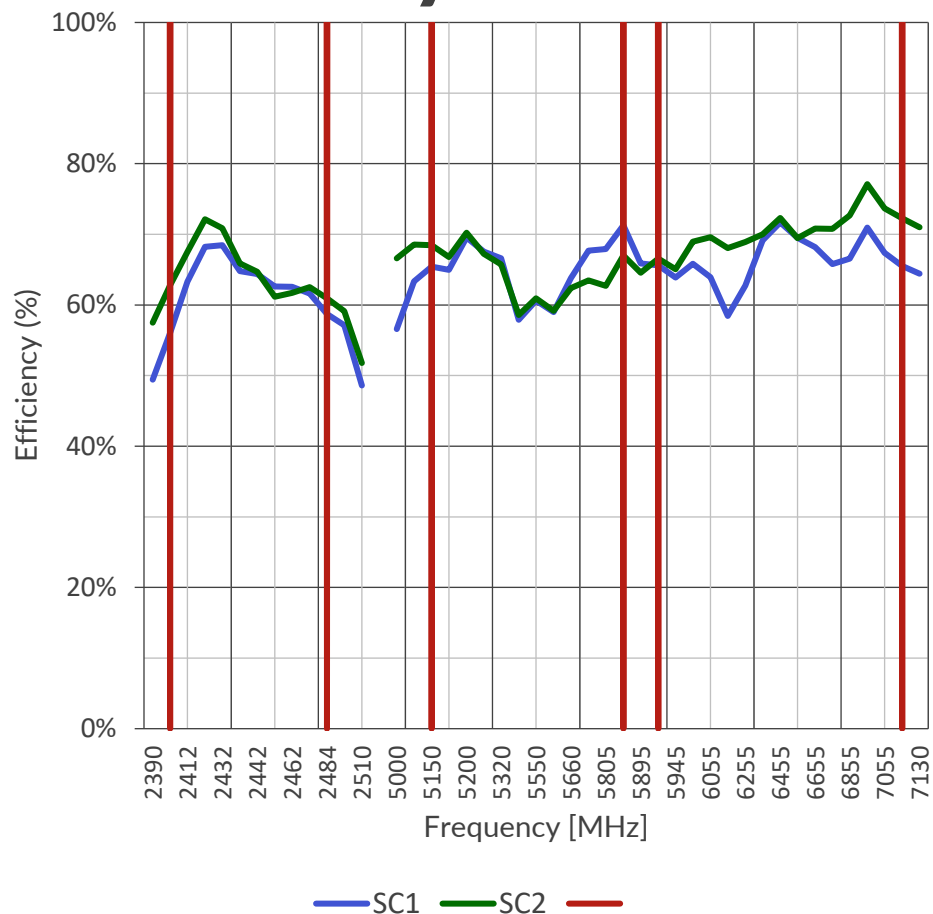


2.4GHz	Max	Mean	Min
SC1_SC2	-17.2	-19.2	-23.3

5/6GHz	Max	Mean	Min
SC1_SC2	-36.7	-45.0	-77.4

Efficiency

Scanning Radio



2.4GHz	Max	Mean	Min
SC1	68 %	63 %	56 %
SC2	72 %	65 %	61 %
Summary	72 %	64 %	56 %

5GHz	Max	Mean	Min
SC1	71 %	65 %	58 %
SC2	70 %	64 %	59 %
Summary	71 %	65 %	58 %

6GHz	Max	Mean	Min
SC1	72 %	66 %	58 %
SC2	77 %	70 %	65 %
Summary	77 %	68 %	58 %

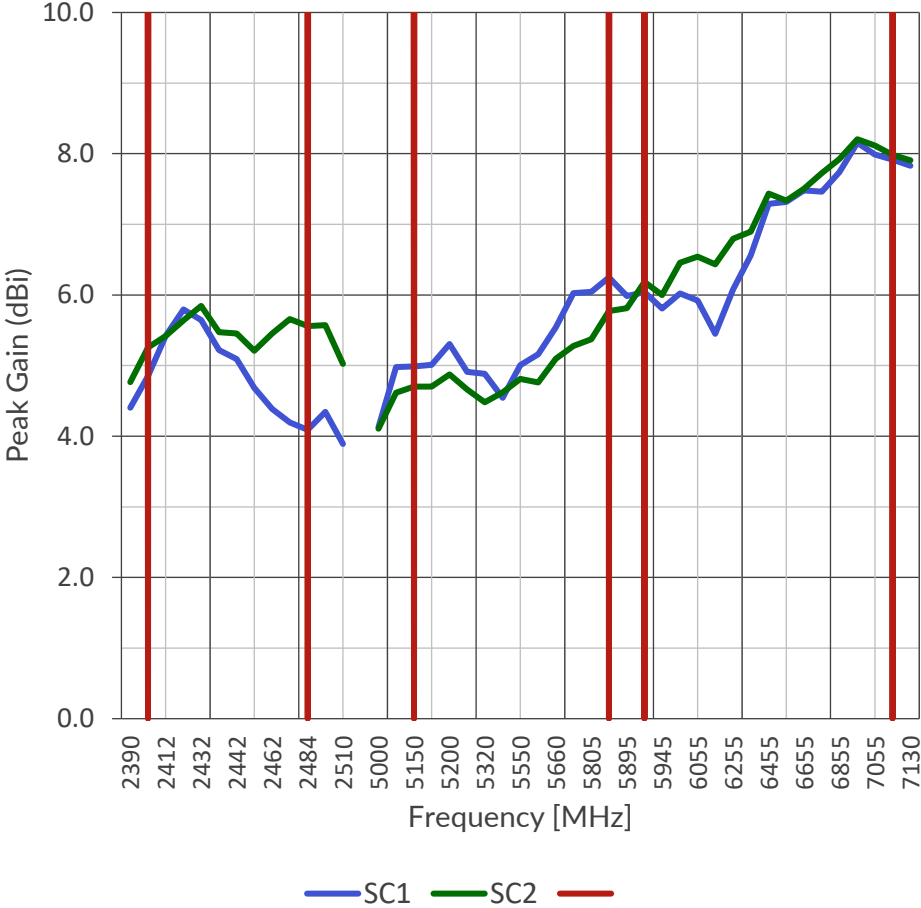
■ Cable Length

SC1 : 141mm

SC2 : 91mm

Peak Gain

Scanning Radio



2.4GHz	Max	Mean	Min
SC1	5.8 dBi	4.9 dBi	4.1 dBi
SC2	5.8 dBi	5.5 dBi	5.2 dBi
Summary	5.8 dBi	5.2 dBi	4.1 dBi

5GHz	Max	Mean	Min
SC1	6.3 dBi	5.3 dBi	4.5 dBi
SC2	5.8 dBi	4.9 dBi	4.5 dBi
Summary	6.3 dBi	5.1 dBi	4.5 dBi

6GHz	Max	Mean	Min
SC1	8.2 dBi	6.9 dBi	5.5 dBi
SC2	8.2 dBi	7.2 dBi	6.0 dBi
Summary	8.2 dBi	7.0 dBi	5.5 dBi

■ Cable Length

SC1 : 141mm

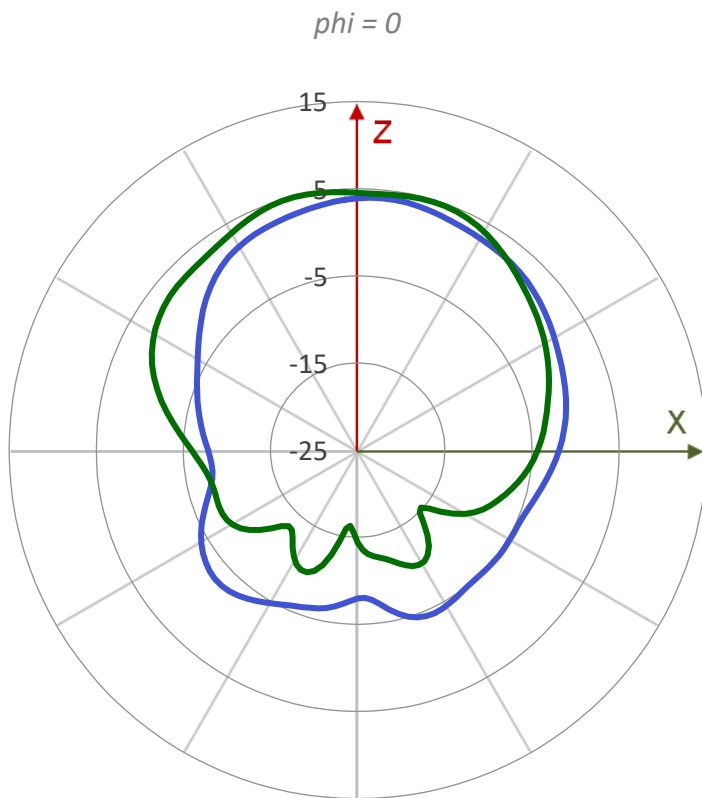
SC2 : 91mm

Realized Gain Pattern

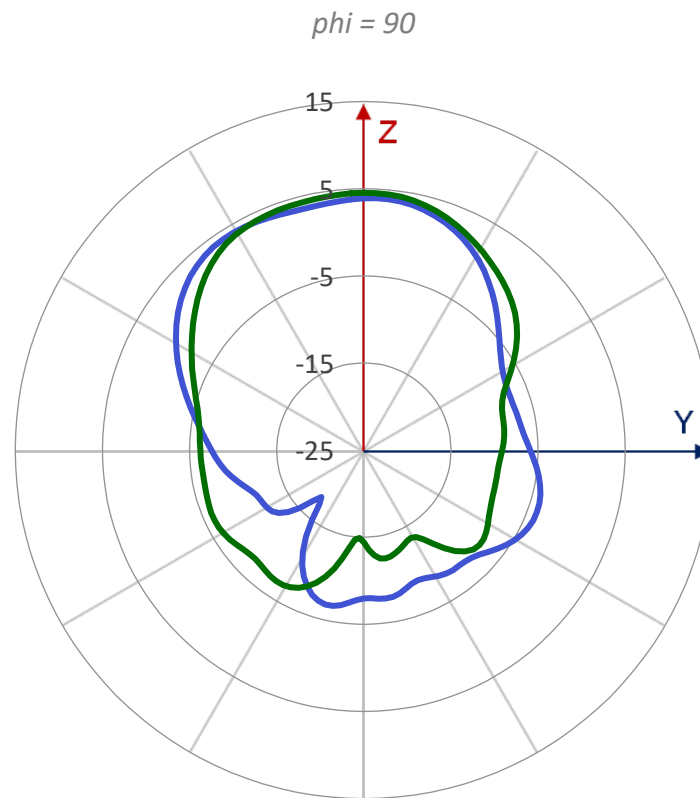
Scanning Radio @2.4G for Gtotal



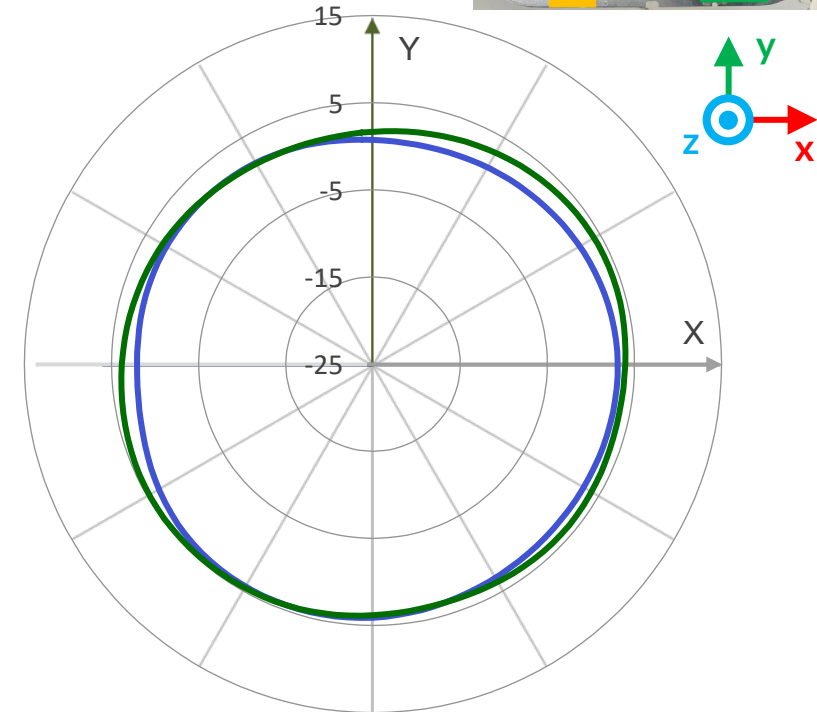
theta = 30



— SC1 — SC2



— SC1 — SC2



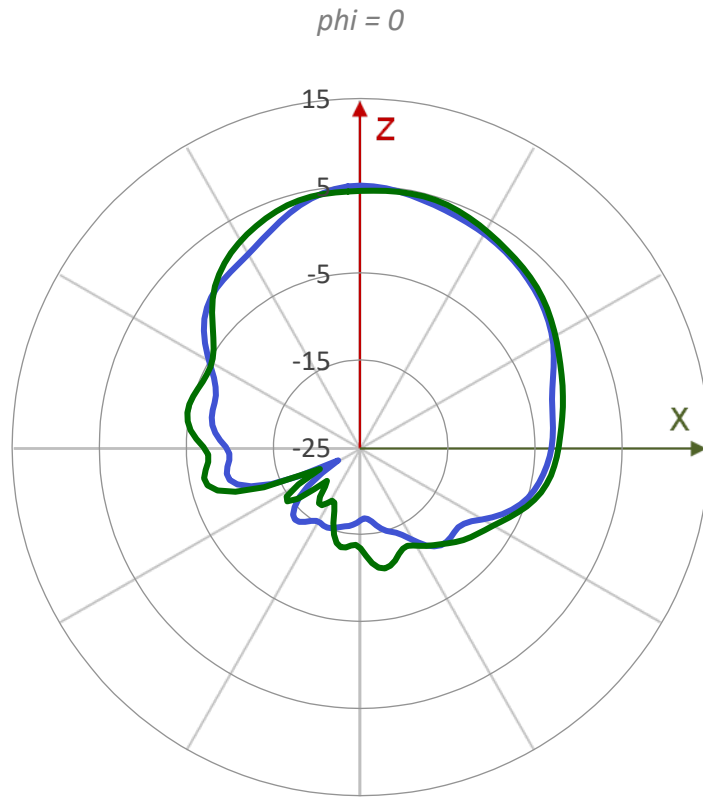
— SC1 — SC2

Realized Gain Pattern

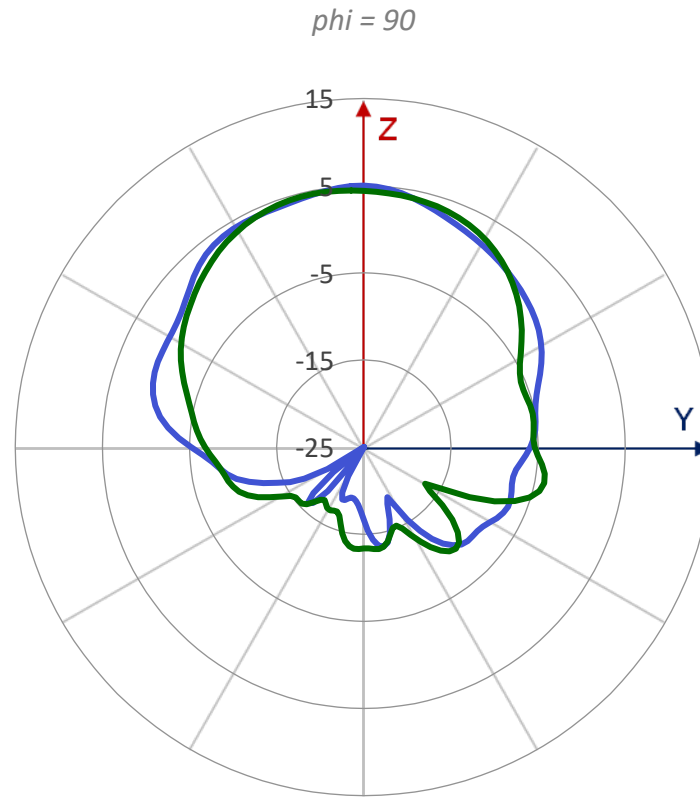
Scanning Radio @5G for Gtotal



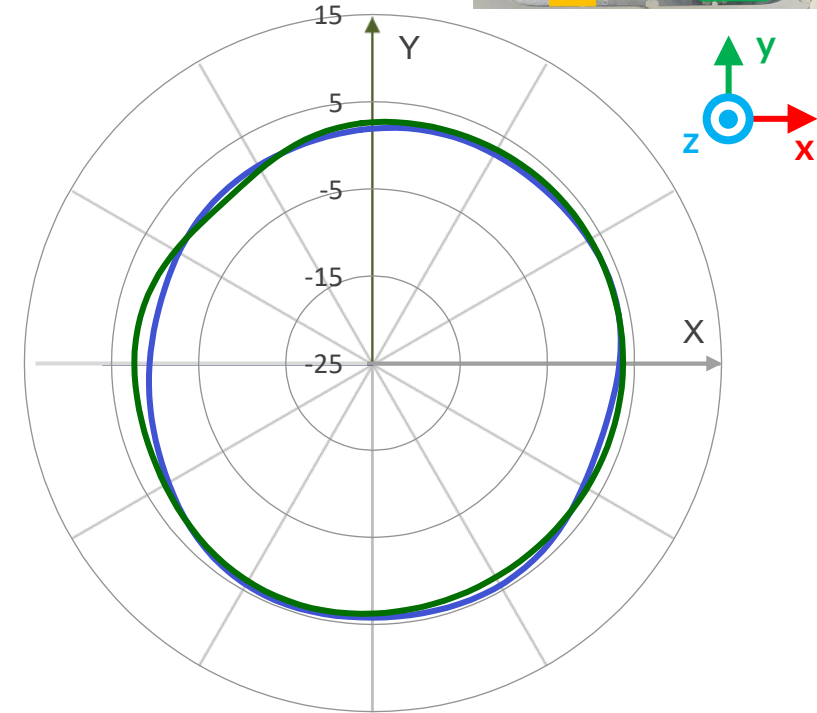
theta = 30



— SC1 — SC2



— SC1 — SC2



— SC1 — SC2

Realized Gain Pattern

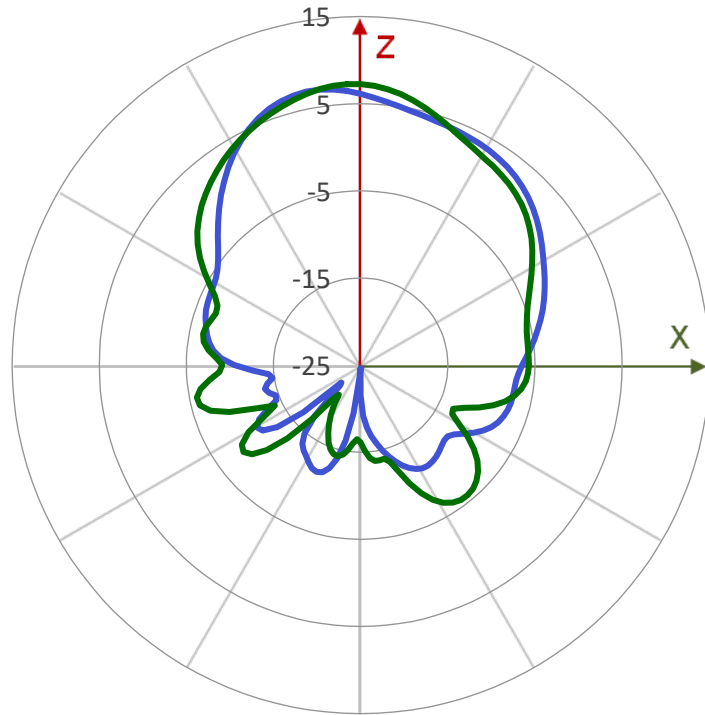
Scanning Radio @6G for Gtotal



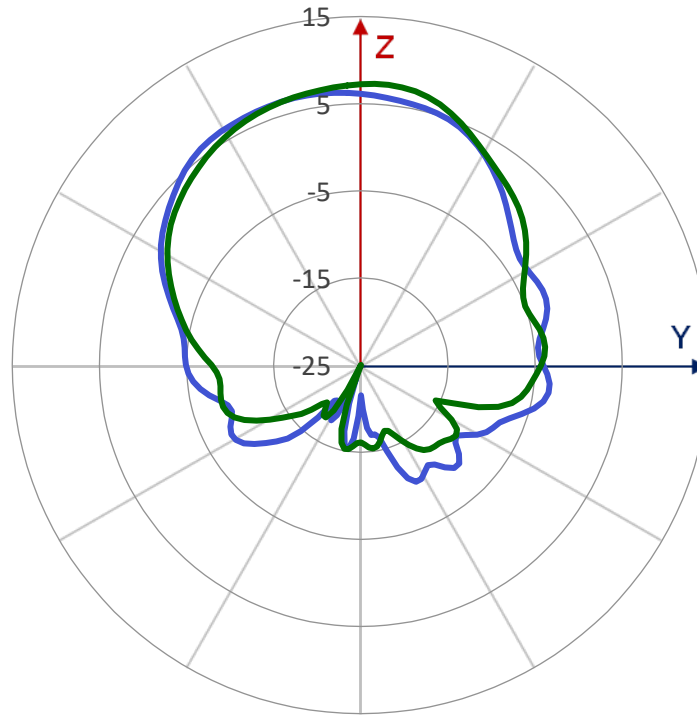
theta = 30

$\phi = 0$

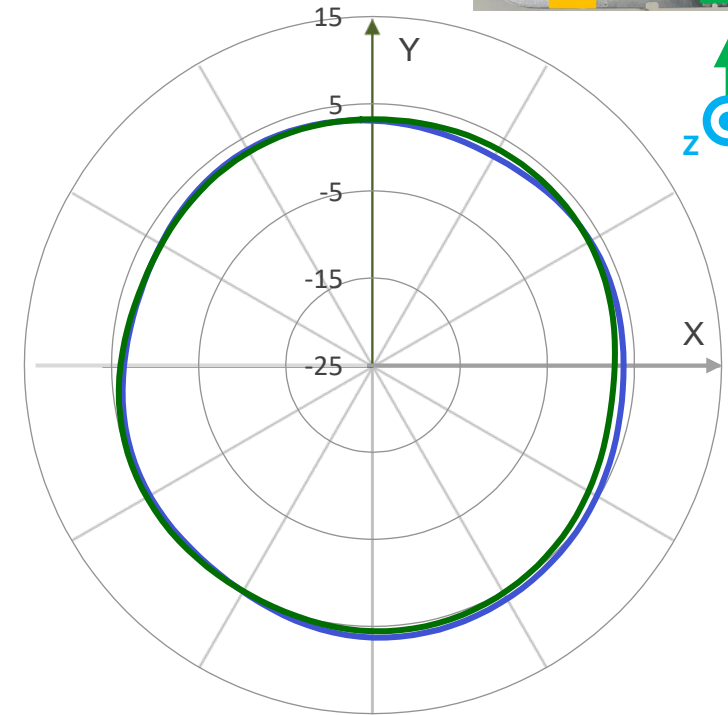
$\phi = 90$



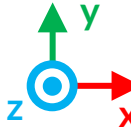
— SC1 — SC2



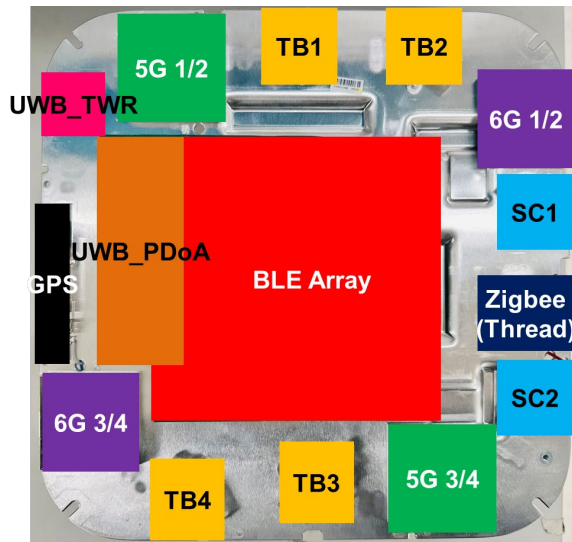
— SC1 — SC2



— SC1 — SC2



Zigbee(Thread)



- **Maximum VSWR**

- 1.8:1 on 2.4GHz

- **Average Efficiency**

- ~58% on 2.4GHz

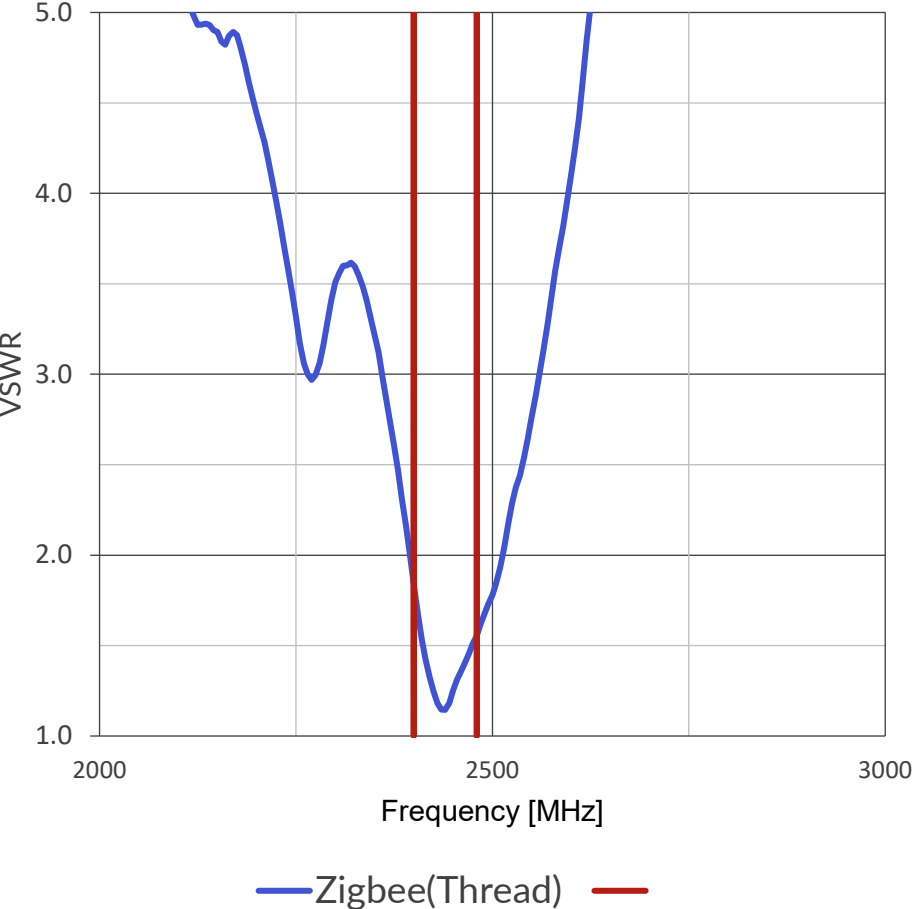
- **Peak Gain**

- 6.6dBi on 2.4GHz

- **Cable Length**

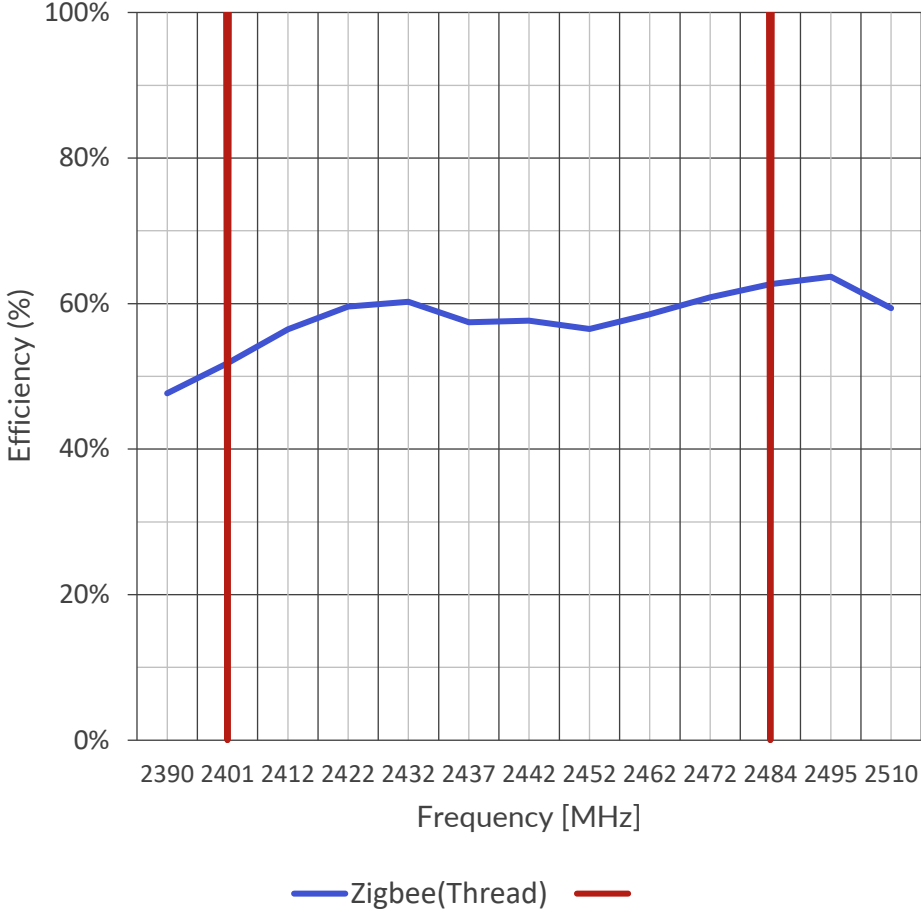
Zigbee(Thread) : 208mm

VSWR Zigbee(Thread)



2.4GHz	Max	Mean	Min
Zigbee(Thread)	1.8	1.4	1.1

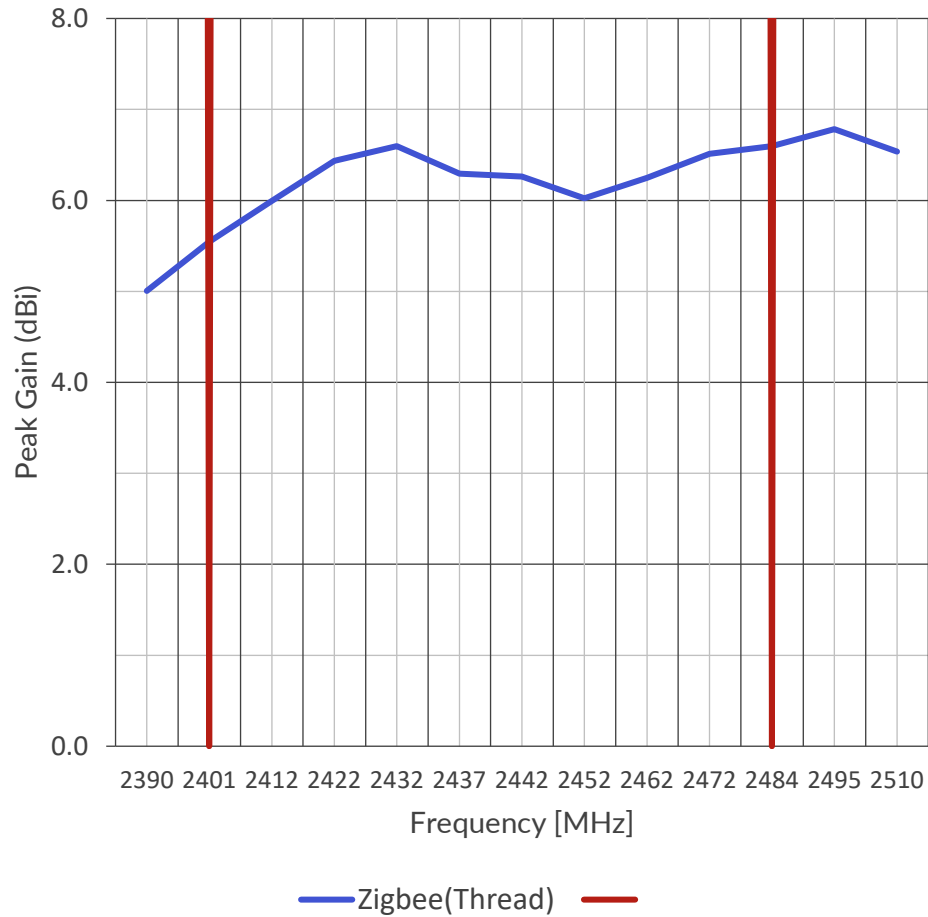
Efficiency Zigbee(Thread)



2.4GHz	Max	Mean	Min
Zigbee(Thread)	63 %	58 %	52 %

■ Cable Length
Zigbee(Thread) : 208mm

Peak Gain Zigbee(Thread)

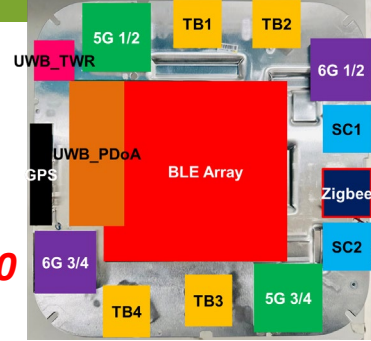


2.4GHz	Max	Mean	Min
Zigbee(Thread)	6.6 dBi	6.3 dBi	5.5 dBi

■ Cable Length

Zigbee(Thread) : 208mm

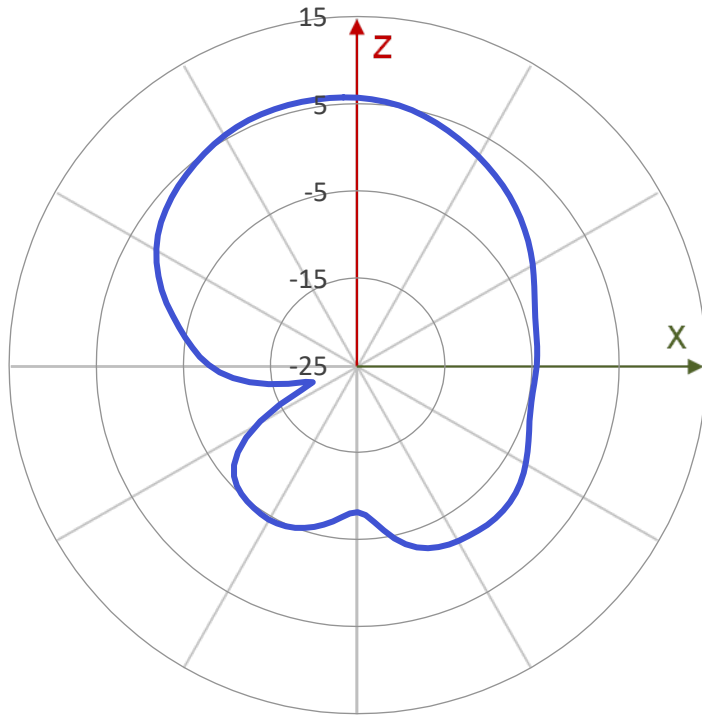
Realized Gain Pattern Zigbee(Thread) @2.4G for Gtotal



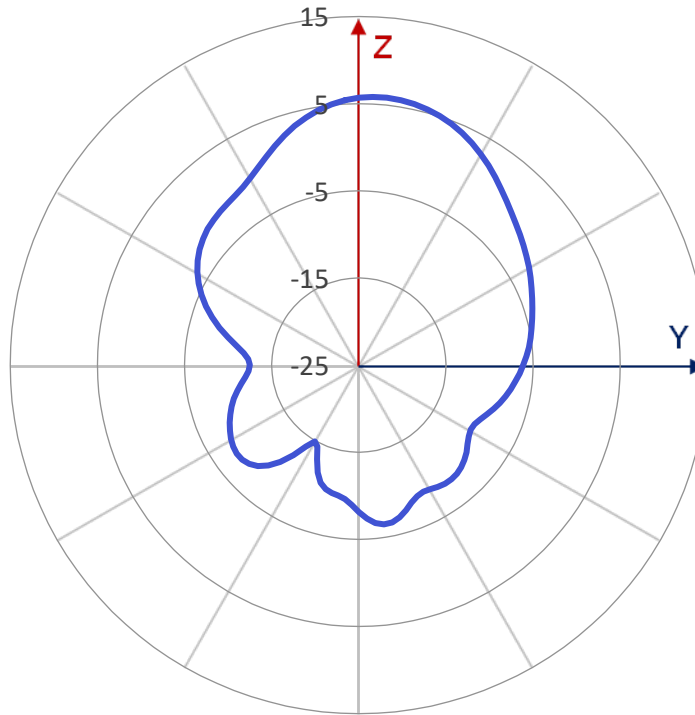
theta = 30

phi = 0

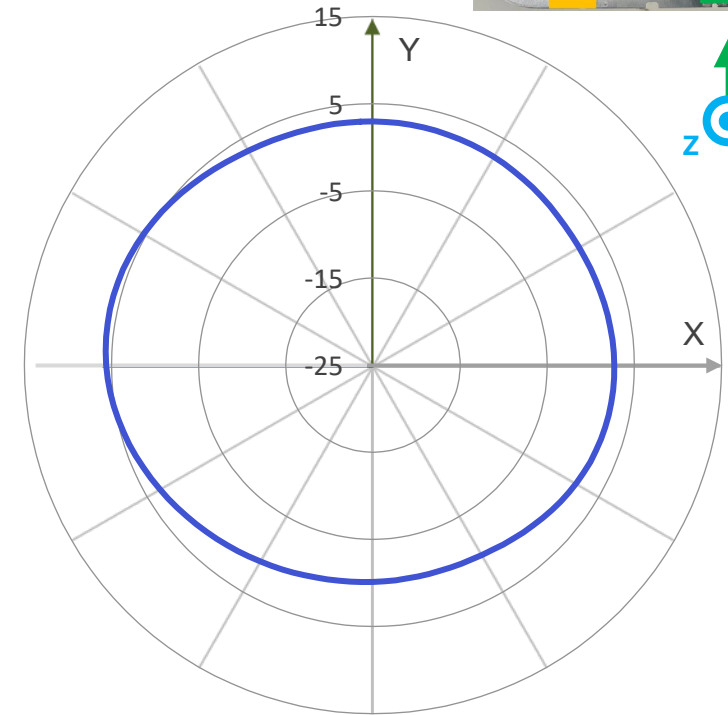
phi = 90



— Zigbee(Thread)

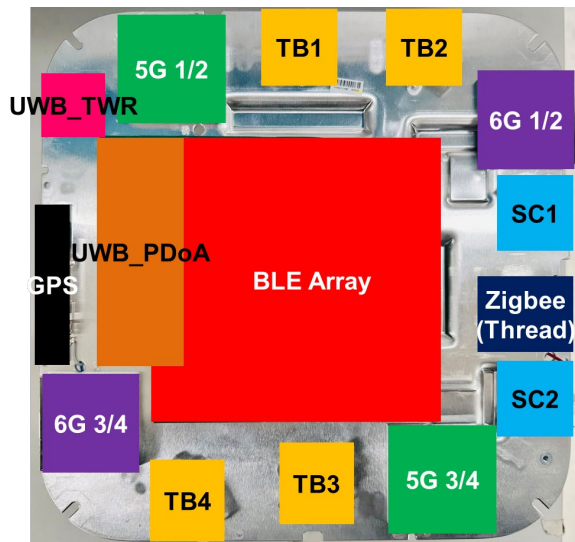


— Zigbee(Thread)



— Zigbee(Thread)

GPS



■ Maximum VSWR

- 2.0:1 on L1 / 2.0:1 on L5

■ Minimum Isolation

- 39.0dB on L1 / 28.2dB on L5 / 34.0dB on 2.4G

■ Average Efficiency

- ~51% on L1 / ~74% on L5

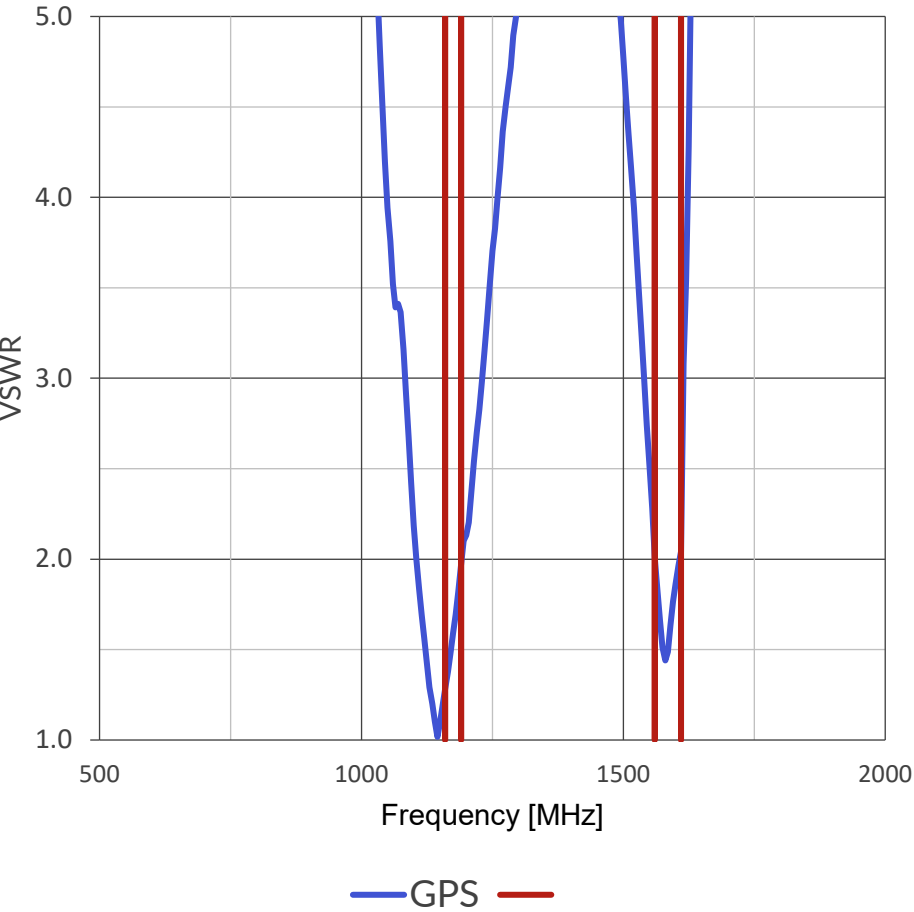
■ Peak Gain

- 2.3dBi on L1 / 4.6dBi on L5

■ Cable Length

GPS : 208mm

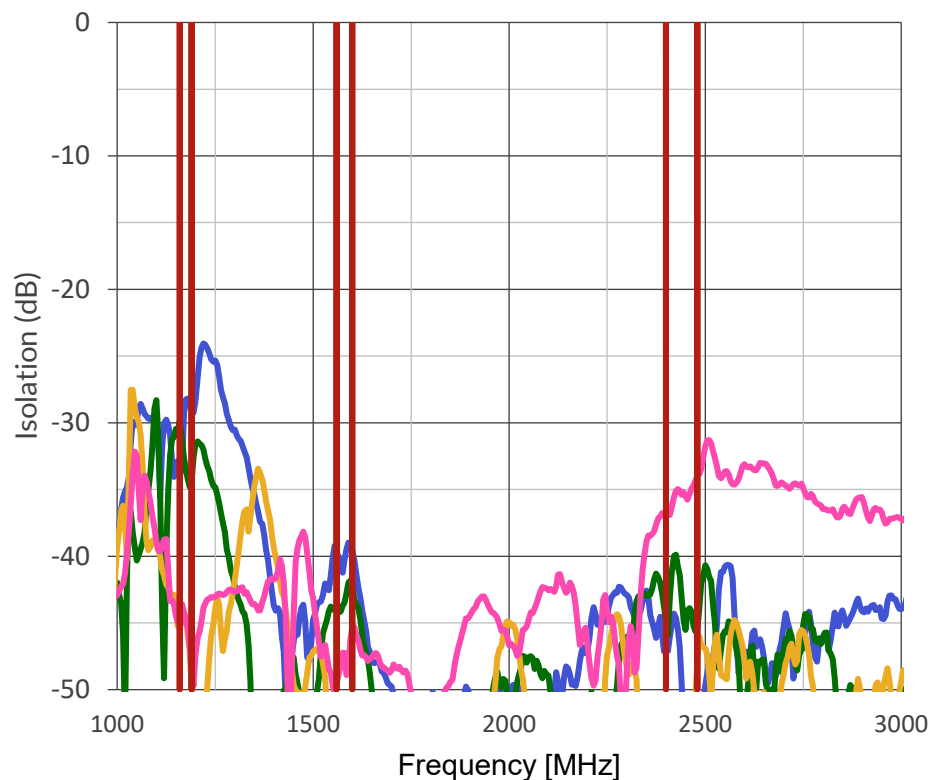
VSWR GPS



L1	Max	Mean	Min
GPS	2.0	1.7	1.4

L5	Max	Mean	Min
GPS	2.0	1.6	1.3

Isolation GPS

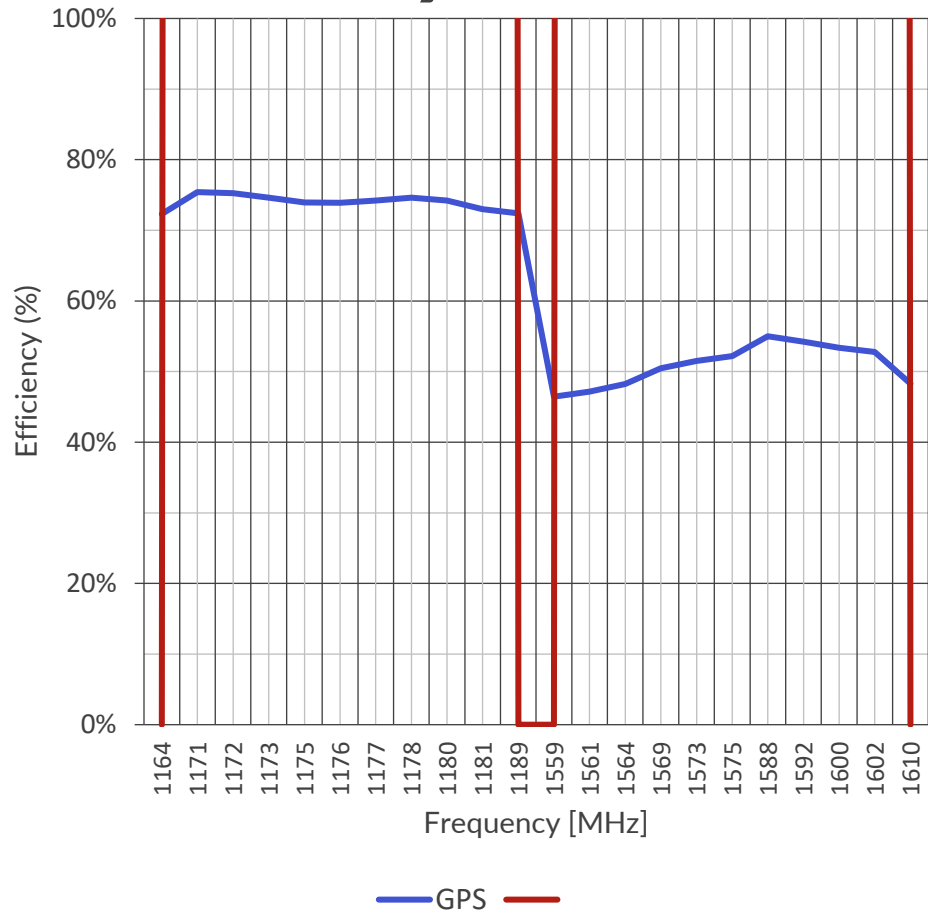


L1	Max	Mean	Min
GPS_TB1	-39.0	-39.9	-41.2
GPS_TB2	-41.8	-43.2	-44.2
GPS_TB3	-52.5	-54.9	-60.1
GPS_TB4	-45.4	-47.8	-49.5
Summary	-39.0	-46.4	-60.1

L5	Max	Mean	Min
GPS_TB1	-28.2	-30.1	-34.0
GPS_TB2	-29.9	-32.9	-34.8
GPS_TB3	-44.2	-45.9	-49.8
GPS_TB4	-43.6	-45.4	-48.5
Summary	-28.2	-38.6	-49.8

2.4GHz	Max	Mean	Min
GPS_TB1	-44.3	-49.6	-55.2
GPS_TB2	-39.9	-43.5	-45.9
GPS_TB3	-47.8	-52.7	-57.3
GPS_TB4	-34.0	-35.5	-37.0
Summary	-34.0	-45.3	-57.3

Efficiency GPS



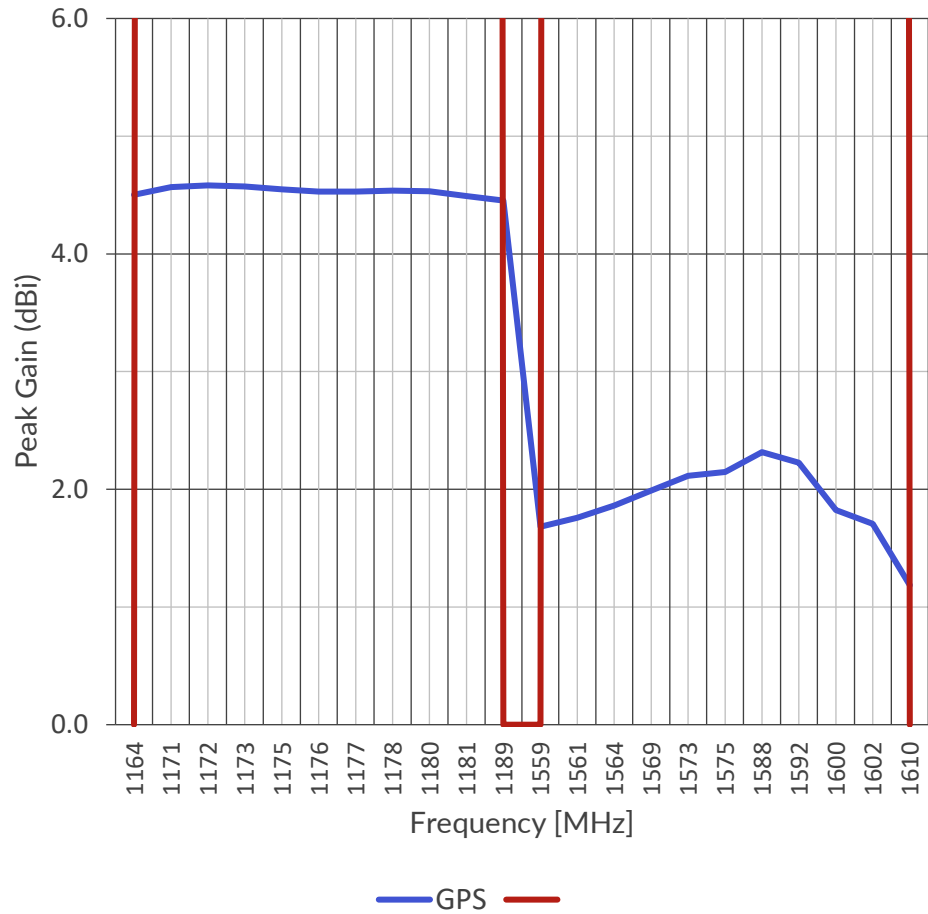
L1	Max	Mean	Min
GPS	55 %	51 %	46 %

L5	Max	Mean	Min
GPS	75 %	74 %	72 %

■ Cable Length

GPS : 208mm

Peak Gain **GPS**



L1	Max	Mean	Min
GPS	2.3 dBi	1.9 dBi	1.2 dBi

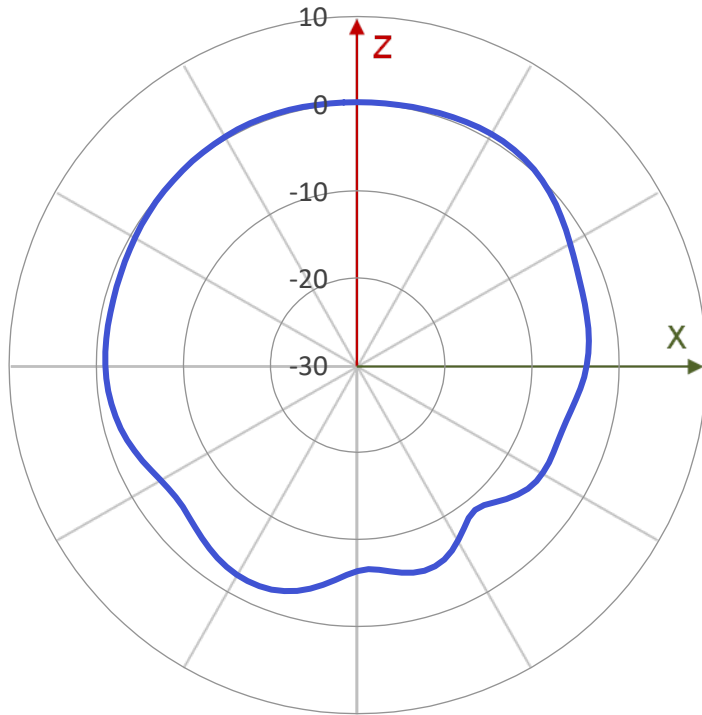
L5	Max	Mean	Min
GPS	4.6 dBi	4.5 dBi	4.5 dBi

■ Cable Length

GPS : 208mm

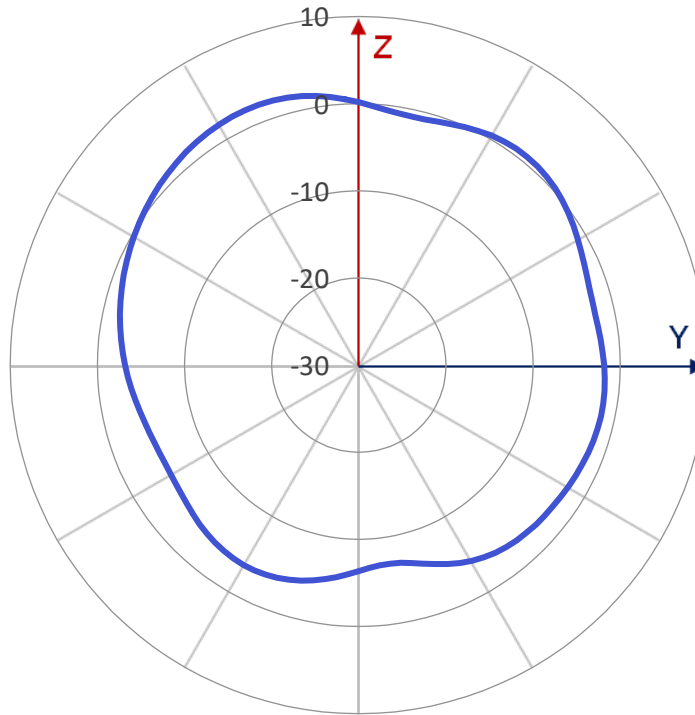
Realized Gain Pattern GPS @L5 for Gtotal

$\phi = 0$



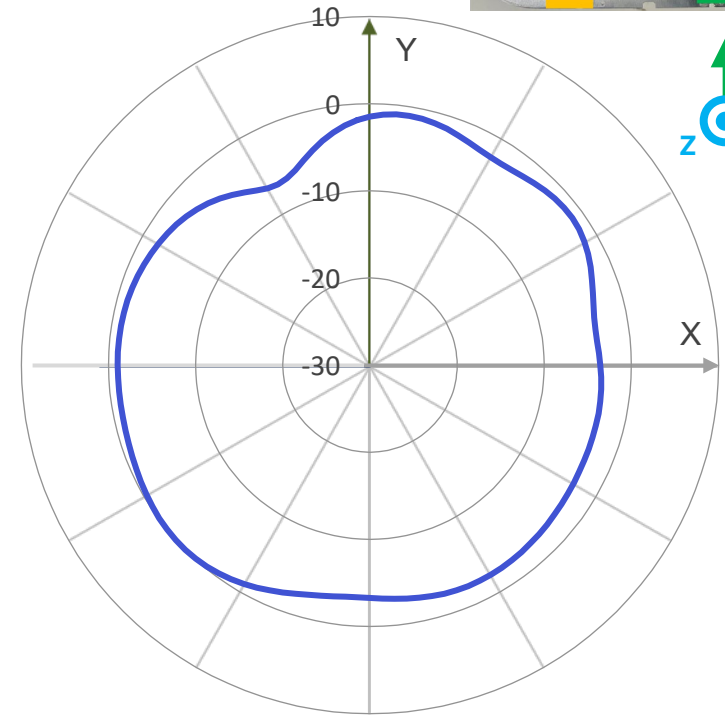
— GPS

$\phi = 90$



— GPS

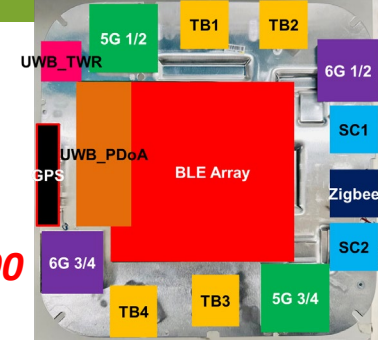
$\theta = 90$



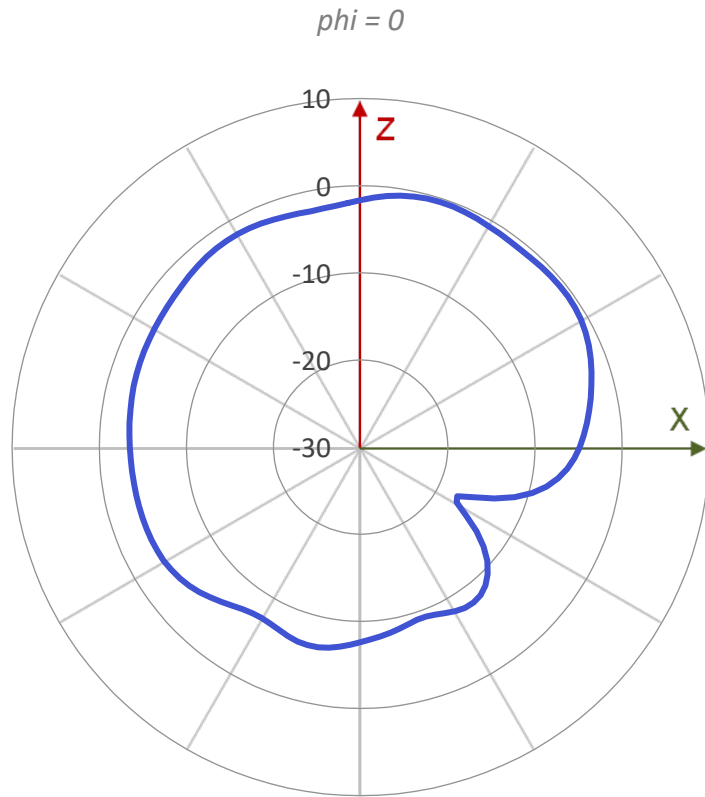
— GPS



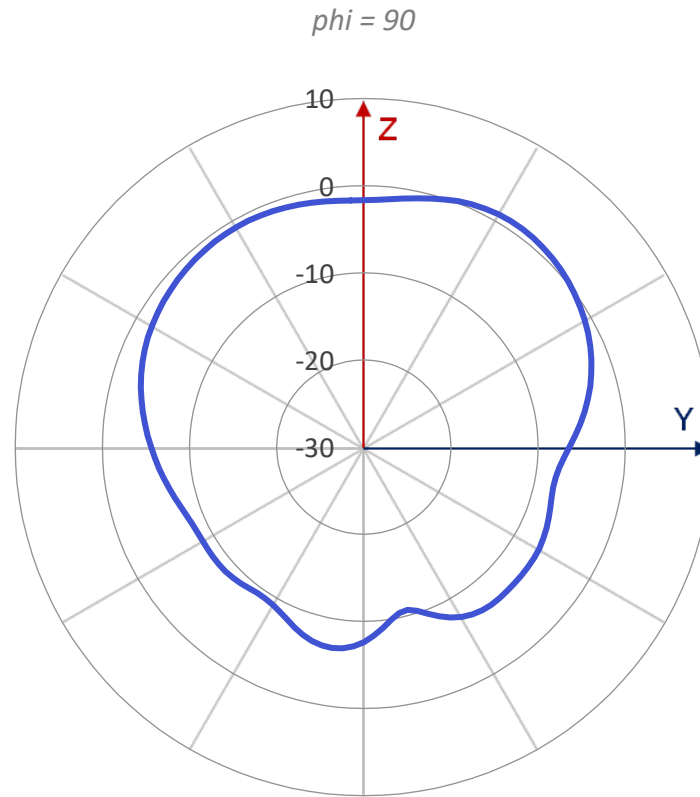
Realized Gain Pattern GPS @L1 for Gtotal



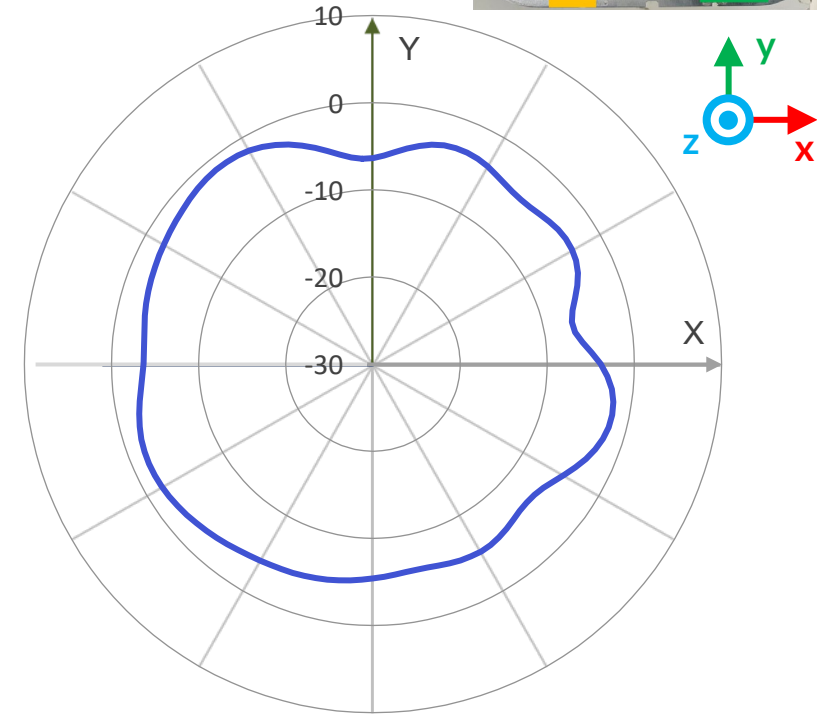
theta = 90



— GPS

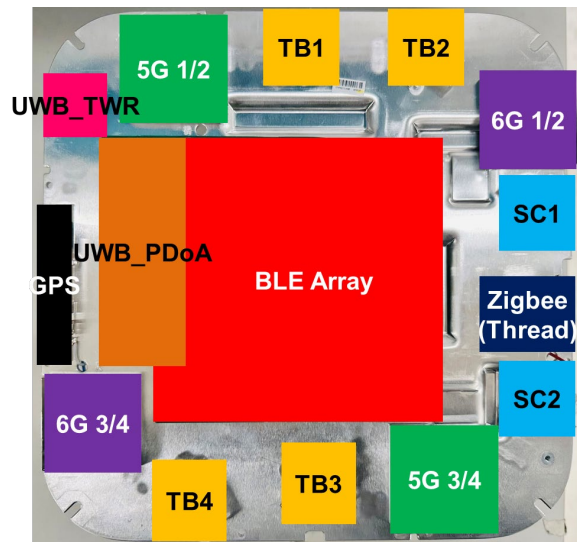


— GPS



— GPS

UWB_TWR



- **Maximum VSWR**

- 1.8:1 on CH 9

- **Average Efficiency**

- ~55% on CH 9

- **Peak Gain**

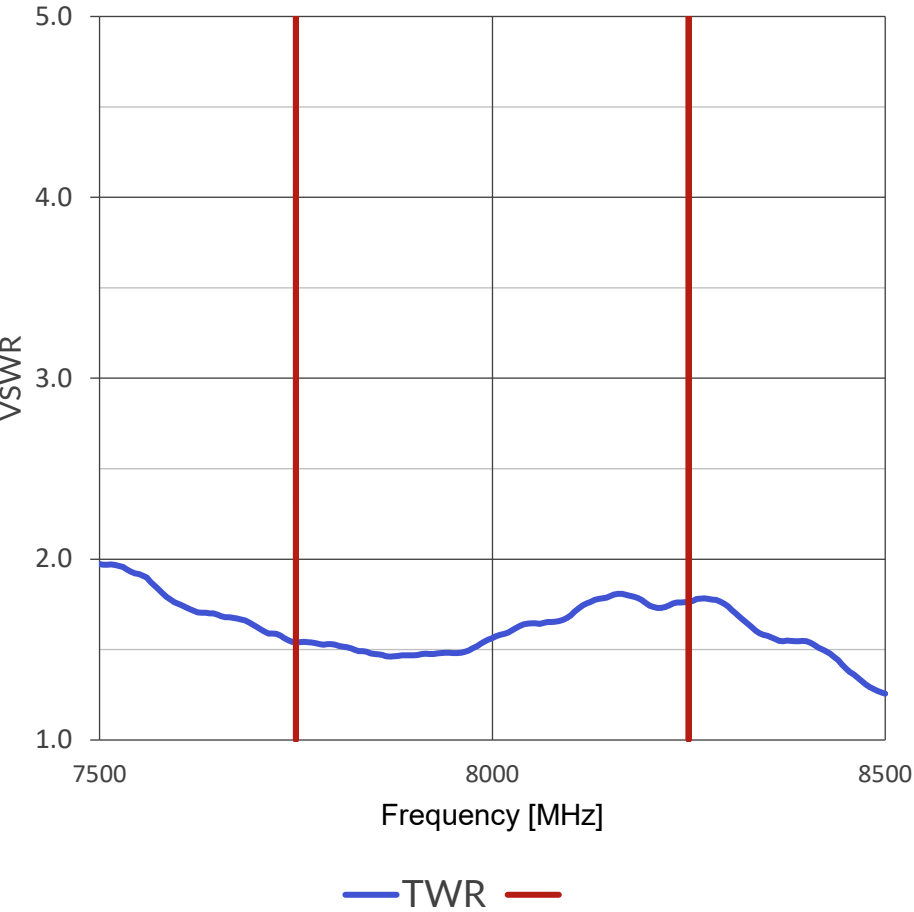
- 6.7dBi on CH 9

- **Cable Length**

TWR : 125mm

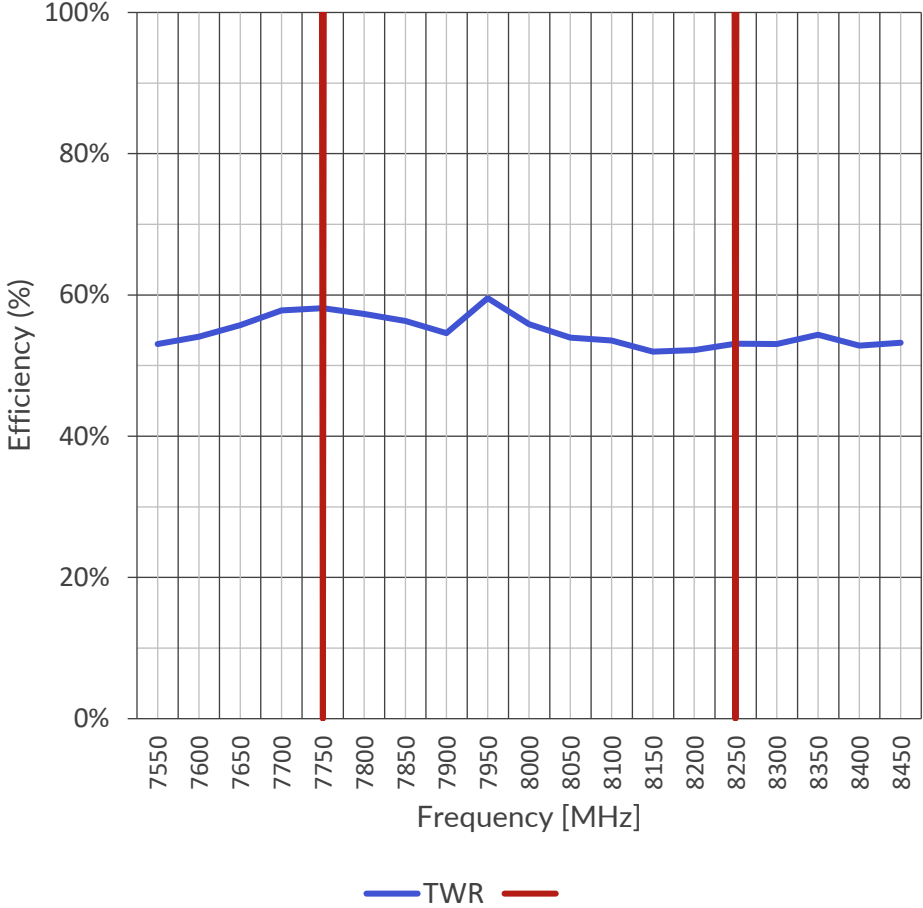
VSWR

UWB_TWR



CH 9	Max	Mean	Min
TWR	1.8	1.6	1.5

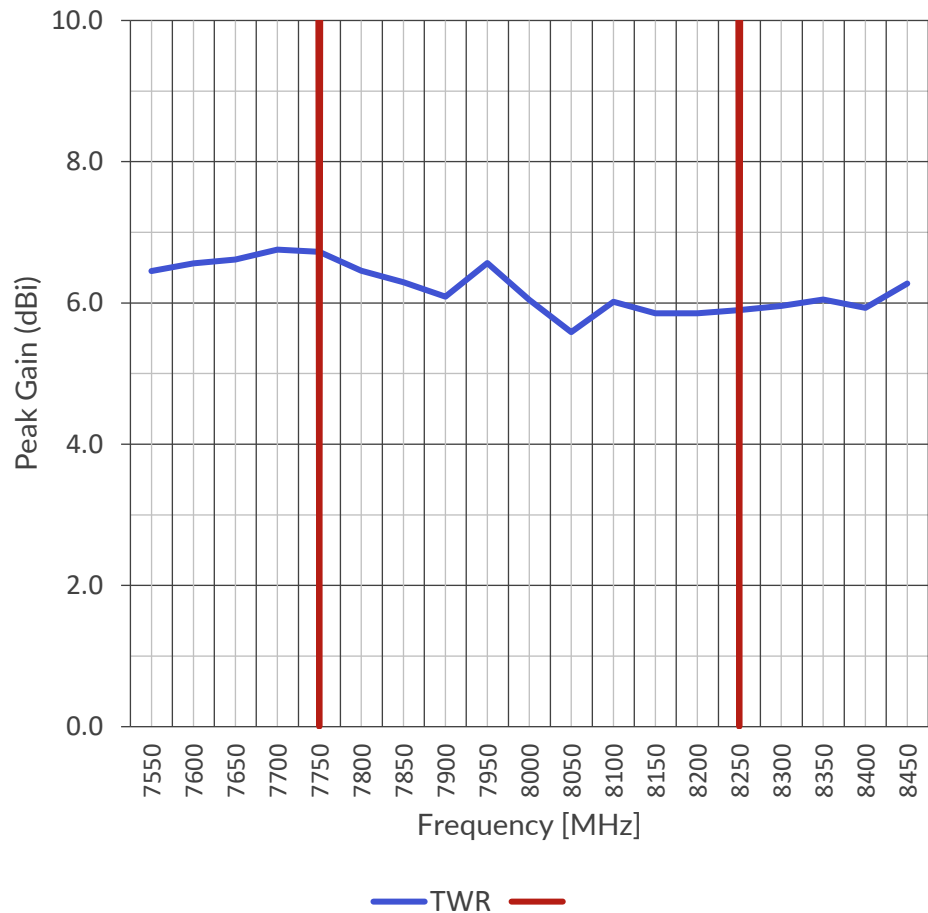
Efficiency UWB_TWR



CH 9	Max	Mean	Min
TWR	60 %	55 %	52 %

■ Cable Length
TWR : 125mm

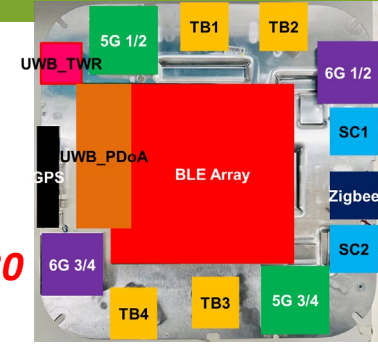
Peak Gain UWB_TWR



CH 9	Max	Mean	Min
TWR	6.7 dBi	6.1 dBi	5.6 dBi

■ Cable Length
TWR : 125mm

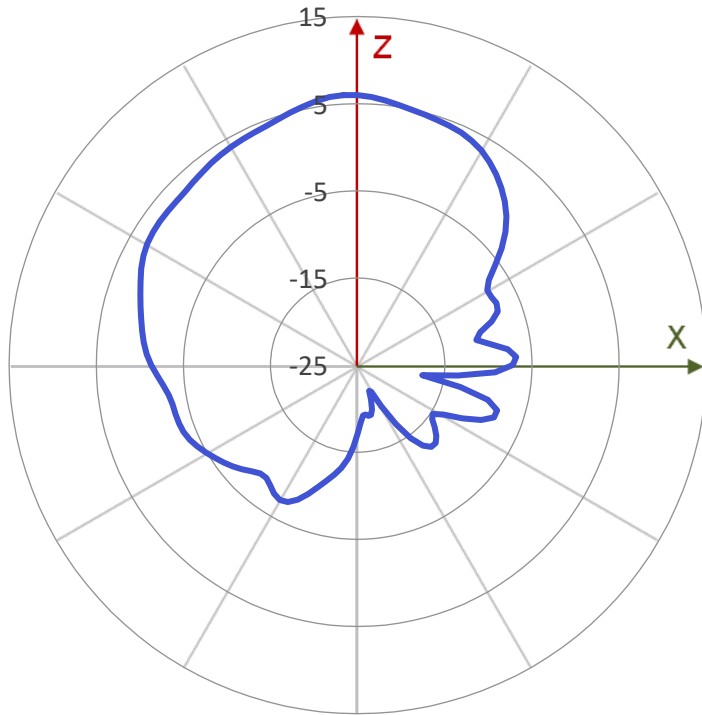
Realized Gain Pattern UWB_TWR @8G for Gtotal



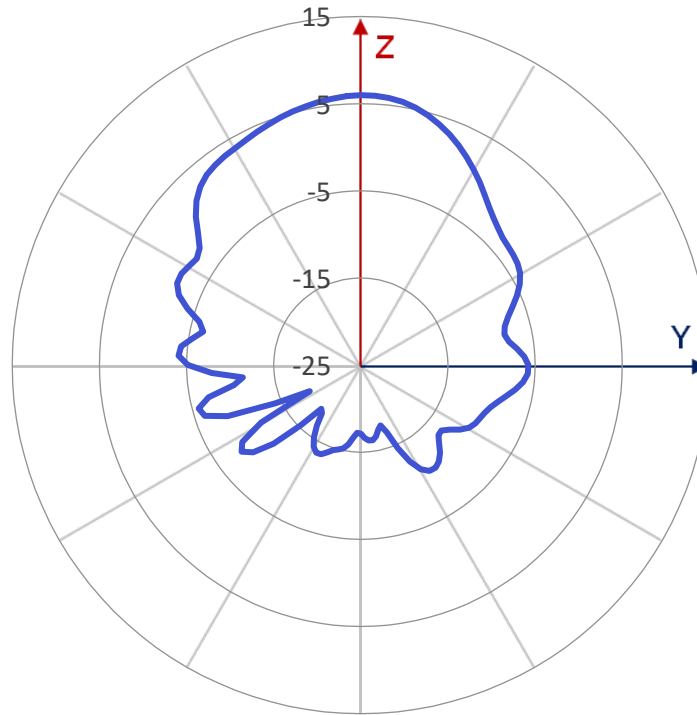
theta = 30

$\phi = 0$

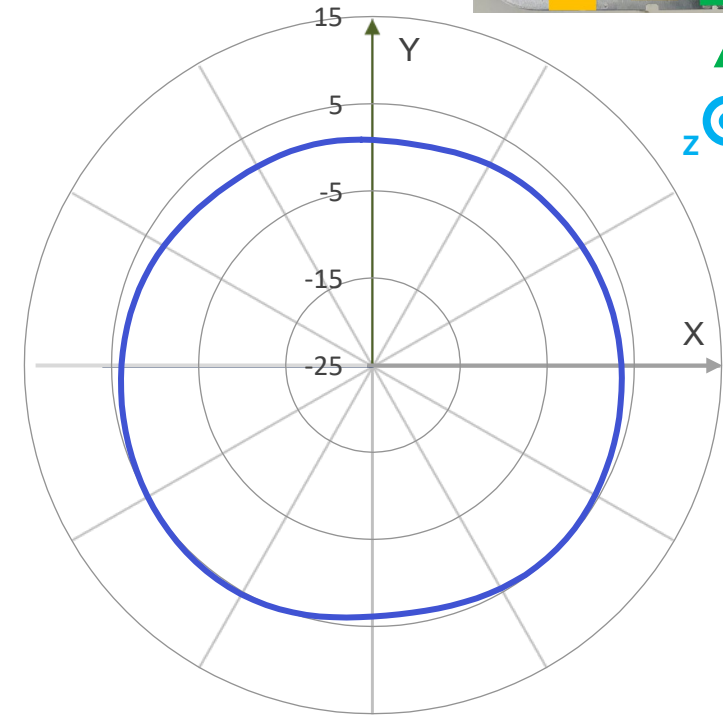
$\phi = 90$



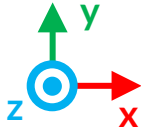
— TWR



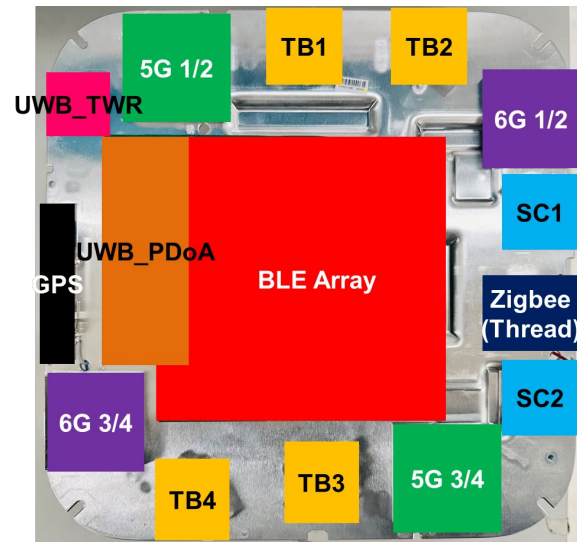
— TWR



— TWR



UWB_PDoA



- **Maximum VSWR**

- 2.7:1 on Ch9

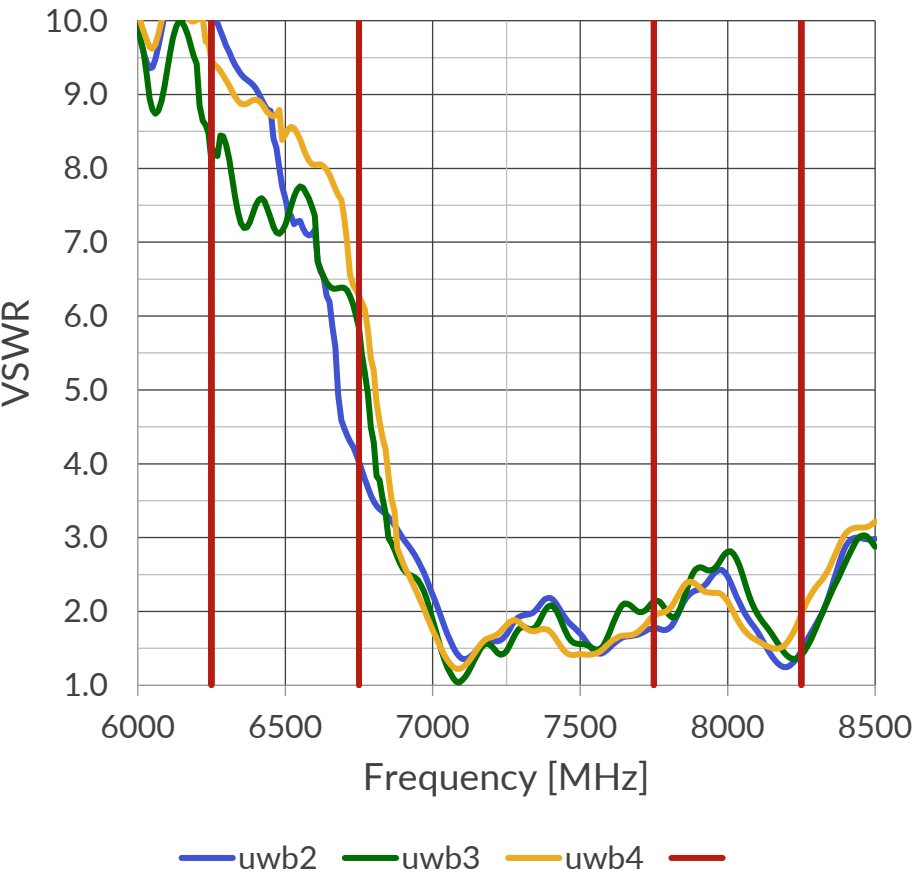
- **Average Efficiency**

- ~18% on Ch9

- **Peak Gain**

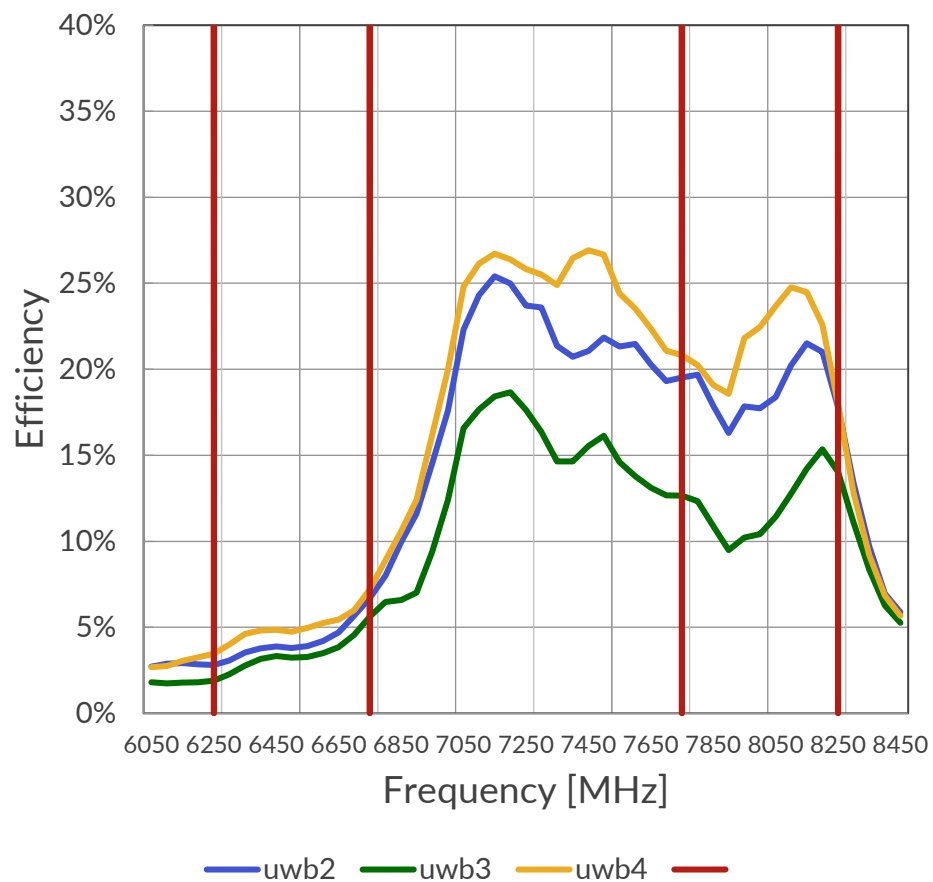
- 3.4dBi on Ch9

VSWR UWB_PDoA



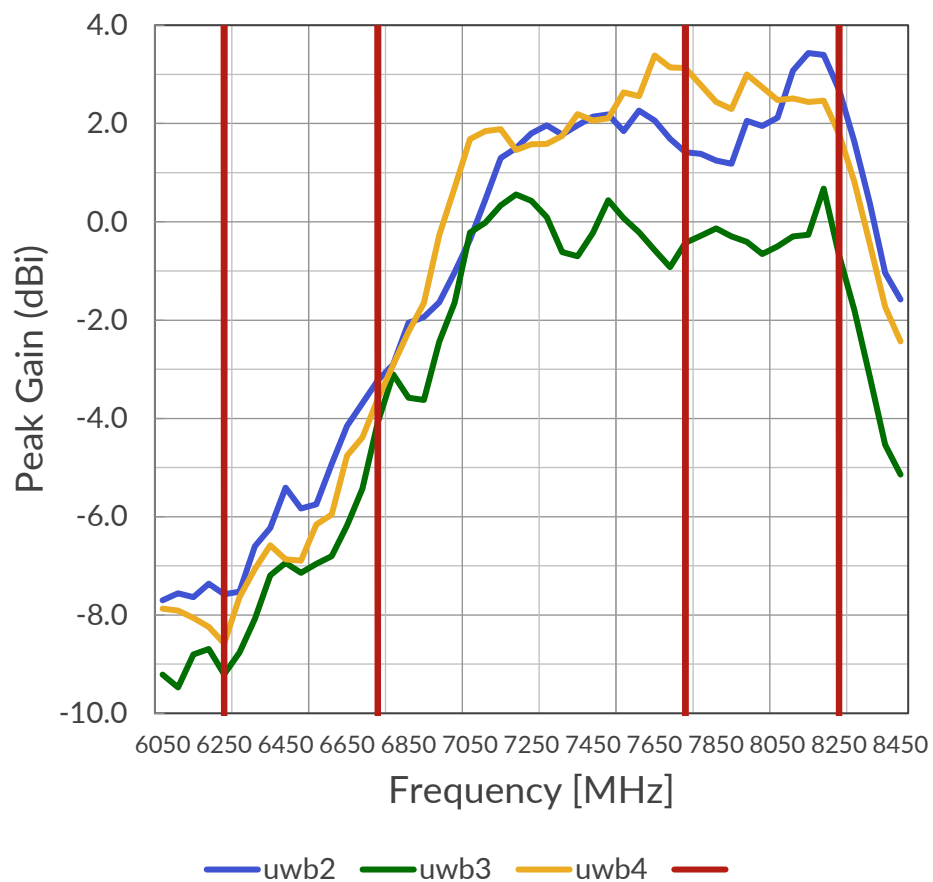
Ch9	Max	Mean	Min
uwb2	2.6	1.9	1.2
uwb3	2.8	2.1	1.4
uwb4	2.4	1.9	1.5
Summary	2.8	2.0	1.2

Efficiency **UWB_PDoA**



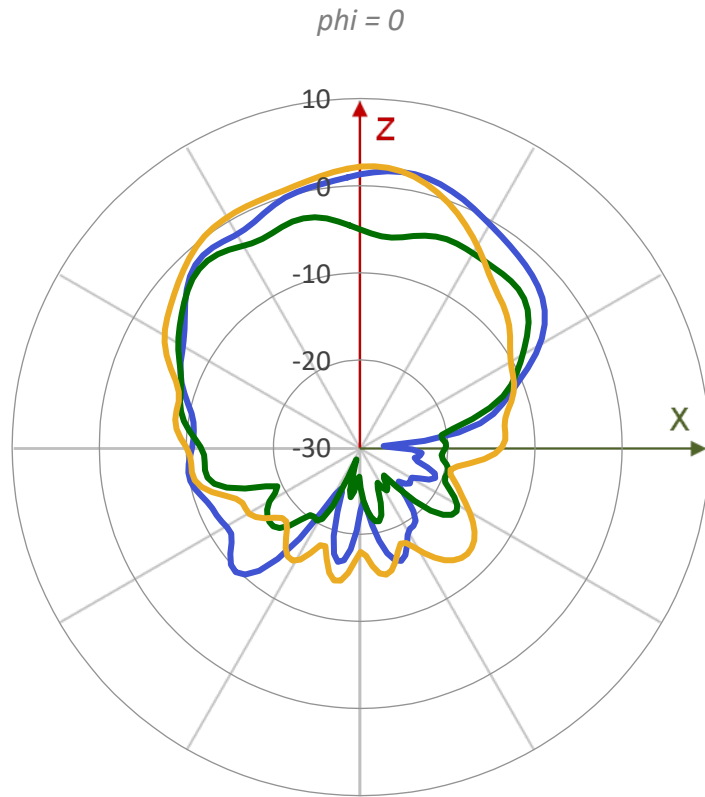
Ch9	Max	Mean	Min
uwb2	22%	19%	16%
uwb3	15%	12%	9%
uwb4	25%	21%	18%
Summary	25%	18%	9%

Peak Gain UWB_PDoA

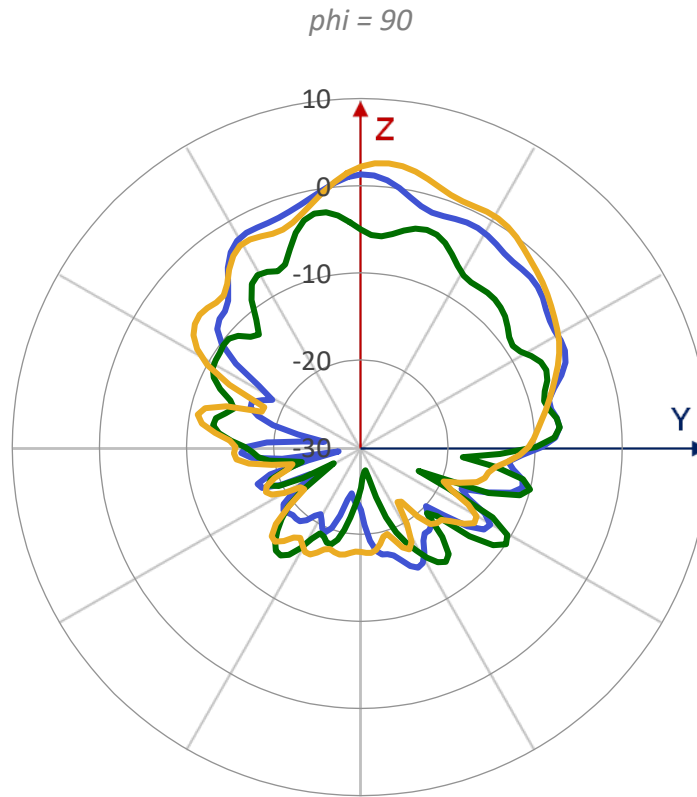


Ch9	Max	Mean	Min
uwb2	3.4 dBi	2.2 dBi	1.2 dBi
uwb3	0.7 dBi	-0.3 dBi	-0.7 dBi
uwb4	3.1 dBi	2.6 dBi	1.8 dBi
Summary	3.4 dBi	1.5 dBi	-0.7 dBi

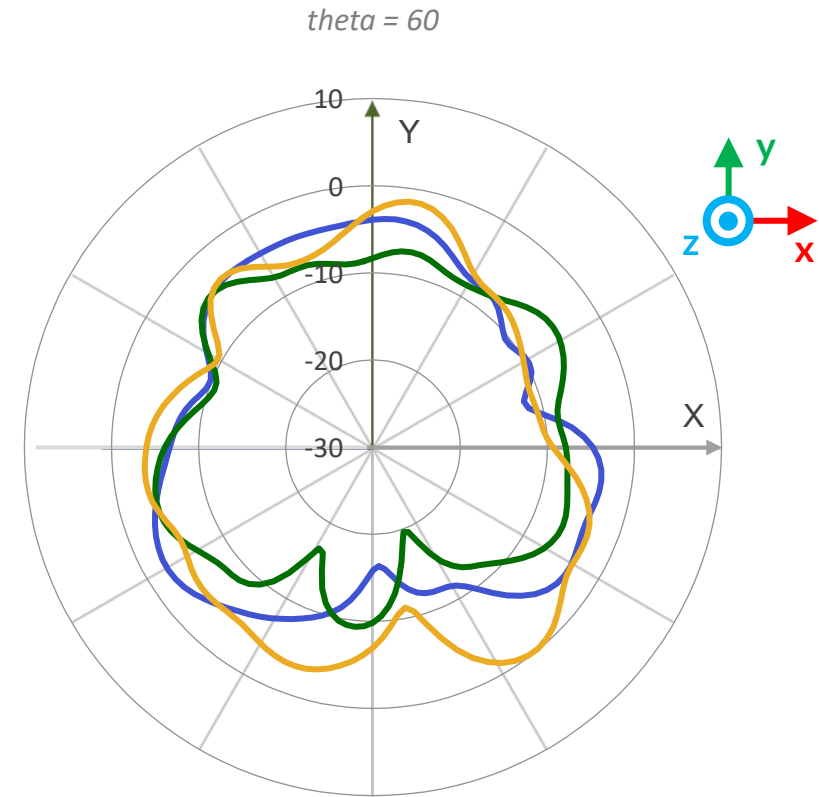
Realized Gain Pattern UWB_PDoA @8000MHz for Gtotal



— uwb2 — uwb3 — uwb4

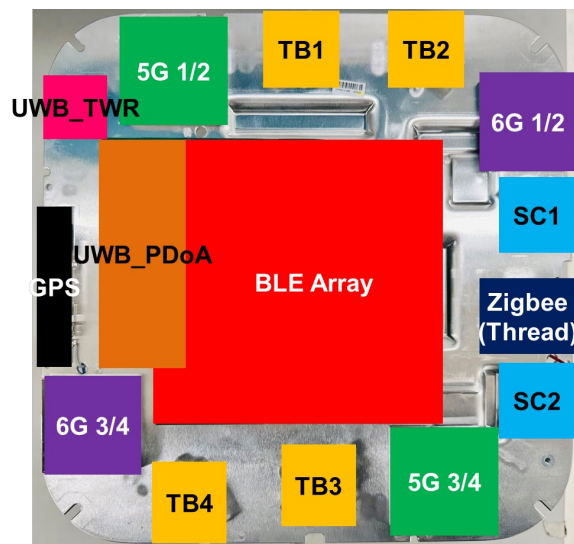


— uwb2 — uwb3 — uwb4



— uwb2 — uwb3 — uwb4

Isolation among Radio



■ Wi-Fi 5G to Wi-Fi Tri-Band

- 46.2dB on 2.4GHz / 30.2dB on 5-7GHz

■ Wi-Fi 6G to Wi-Fi Tri-Band

- 40.0dB on 2.4GHz / 31.3dB on 5-7GHz

■ Wi-Fi 6G to Wi-Fi 5G

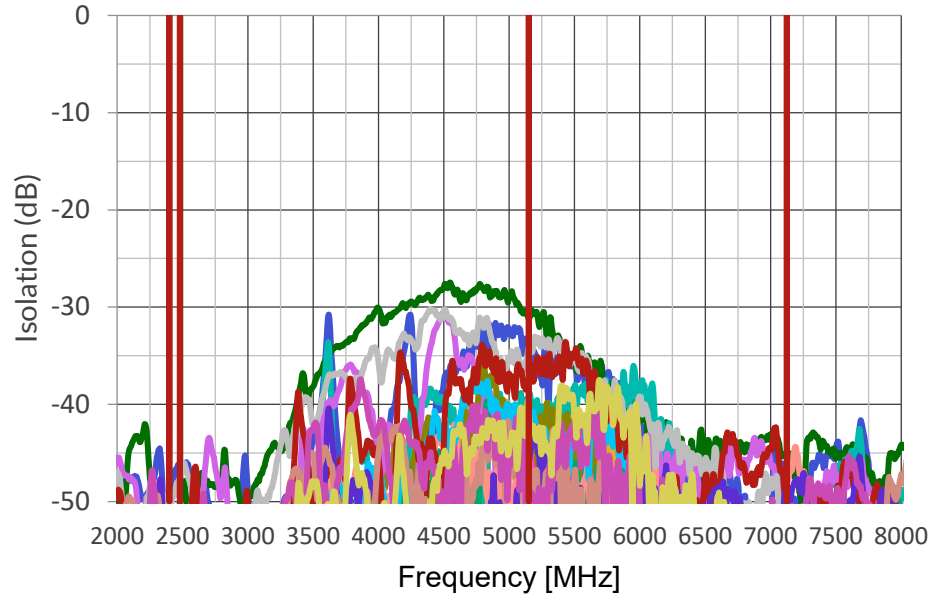
- 38.7dB on 5-7GHz

■ UWB_TWR to Wi-Fi Radio

- 33.0dB on 5GHz / 33.6dB on 6GHz / 40.0dB on Ch9

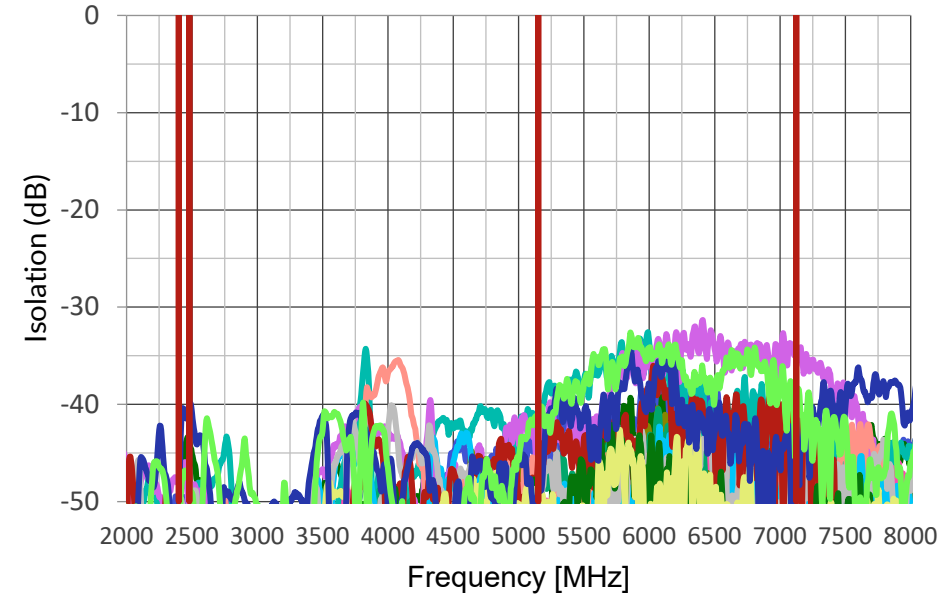
Isolation

Wi-Fi Tri-band to Wi-Fi 5G / Wi-Fi Tri-Band to Wi-Fi 6G



TB1_5G1 TB1_5G2 TB1_5G3 TB1_5G4
TB2_5G1 TB2_5G2 TB2_5G3 TB2_5G4
TB3_5G1 TB3_5G2 TB3_5G3 TB3_5G4
TB4_5G1 TB4_5G2 TB4_5G3 TB4_5G4

➤ Wi-Fi Tri-Band to Wi-Fi 5G

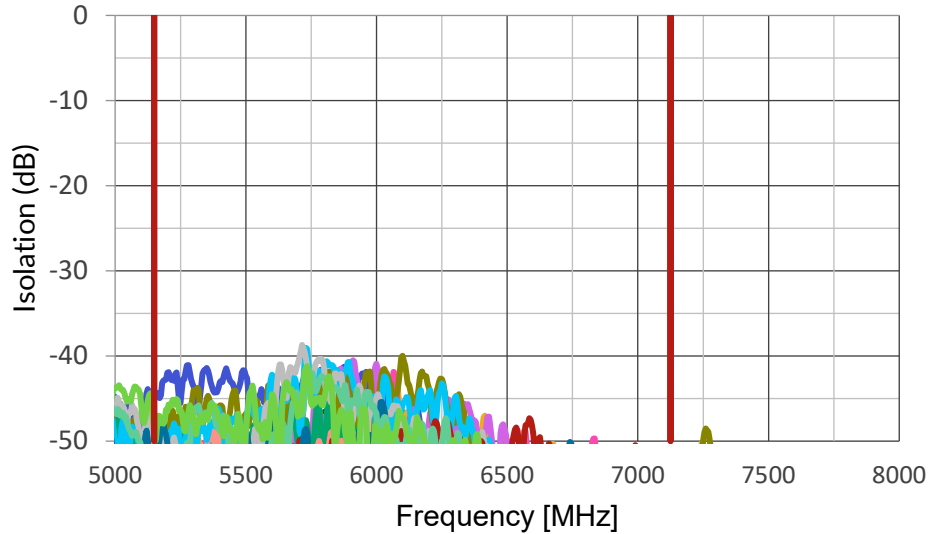


TB1_6G1 TB1_6G2 TB1_6G3 TB1_6G4
TB2_6G1 TB2_6G2 TB2_6G3 TB2_6G4
TB3_6G1 TB3_6G2 TB3_6G3 TB3_6G4
TB4_6G1 TB4_6G2 TB4_6G3 TB4_6G4

➤ Wi-Fi Tri-Band to Wi-Fi 6G

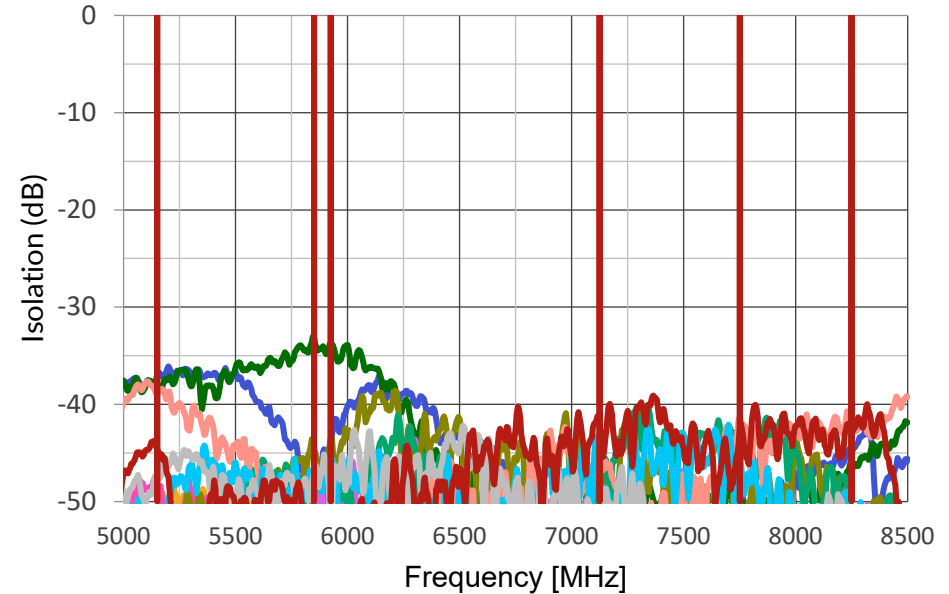
Isolation

Wi-Fi 5G to Wi-Fi 6G / UWB_TWR to Wi-Fi Radio



— 5G1_6G1 — 5G1_6G2 — 5G1_6G3
 — 5G1_6G4 — 5G2_6G1 — 5G2_6G2
 — 5G2_6G3 — 5G2_6G4 — 5G3_6G1
 — 5G3_6G2 — 5G3_6G3 — 5G3_6G4
 — 5G4_6G1 — 5G4_6G2 — 5G4_6G3
 — 5G4_6G4 —

➤ Wi-Fi 5G to Wi-Fi 6G



— TWR_5G1 — TWR_5G2 — TWR_5G3
 — TWR_5G4 — TWR_6G1 — TWR_6G2
 — TWR_6G3 — TWR_6G4 — TWR_TB1
 — TWR_TB2 — TWR_TB3 — TWR_TB4
 —

➤ UWB_TWR to Wi-Fi Radio

BLE Array – Directional Beam



■ Efficiency

- ~15% on 2.4GHz [Beam1~Beam8]
- ~27% on 2.4GHz [Beam9]

■ Peak Gain

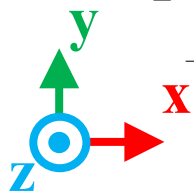
- 4.3dBi on 2.4GHz [Beam1~Beam8]
- 3.7dBi on 2.4GHz [Beam9]

■ Beam Width

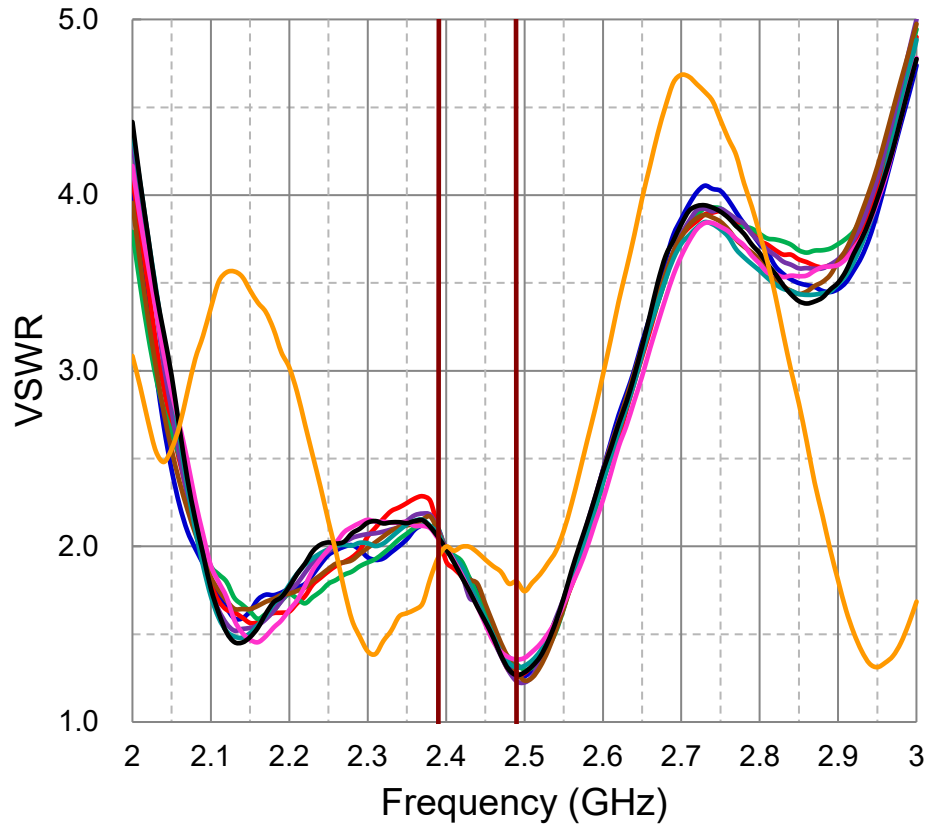
- ~46° on 2.4GHz [Beam1~Beam8]

■ Front to Back Ratio

- ~11.8dB on 2.4GHz [Beam1~Beam8]



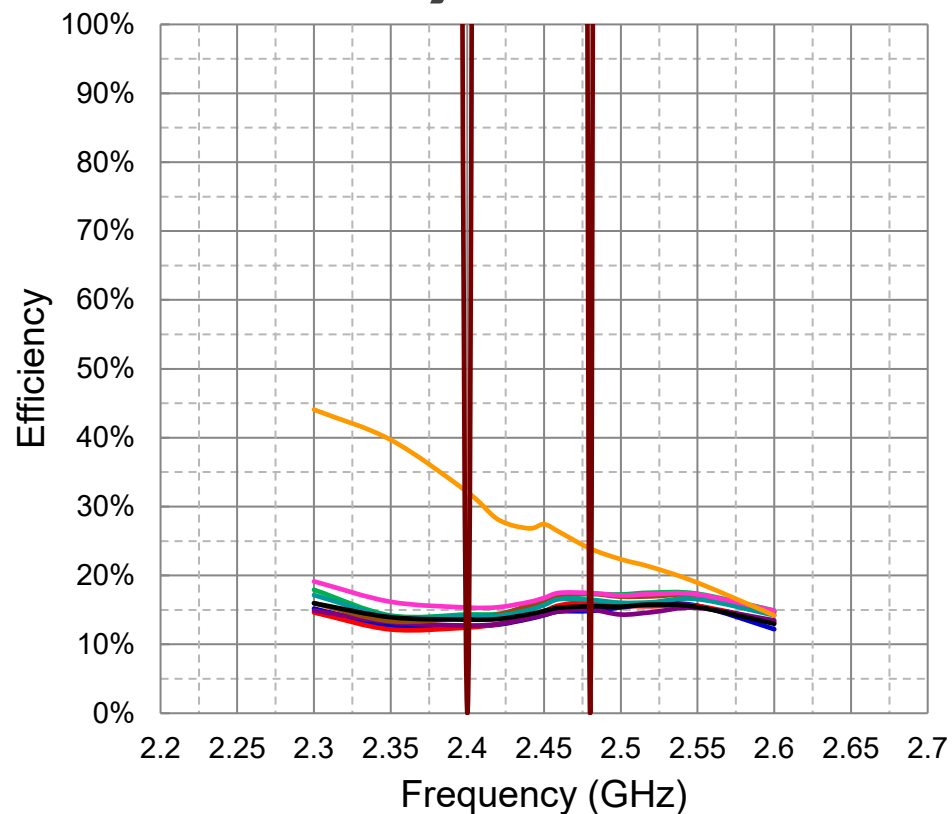
VSWR Directional Beam



Beam1 Beam2 Beam3 Beam4 Beam5
 Beam6 Beam7 Beam8 Beam9

2.4GHz	Max	Mean	Min
Beam 1	2.0	1.7	1.3
Beam 2	1.9	1.6	1.3
Beam 3	2.0	1.7	1.4
Beam 4	2.0	1.7	1.4
Beam 5	2.0	1.7	1.4
Beam 6	2.0	1.7	1.4
Beam 7	2.0	1.7	1.4
Beam 8	2.0	1.7	1.3
Beam 9	2.0	1.9	1.8

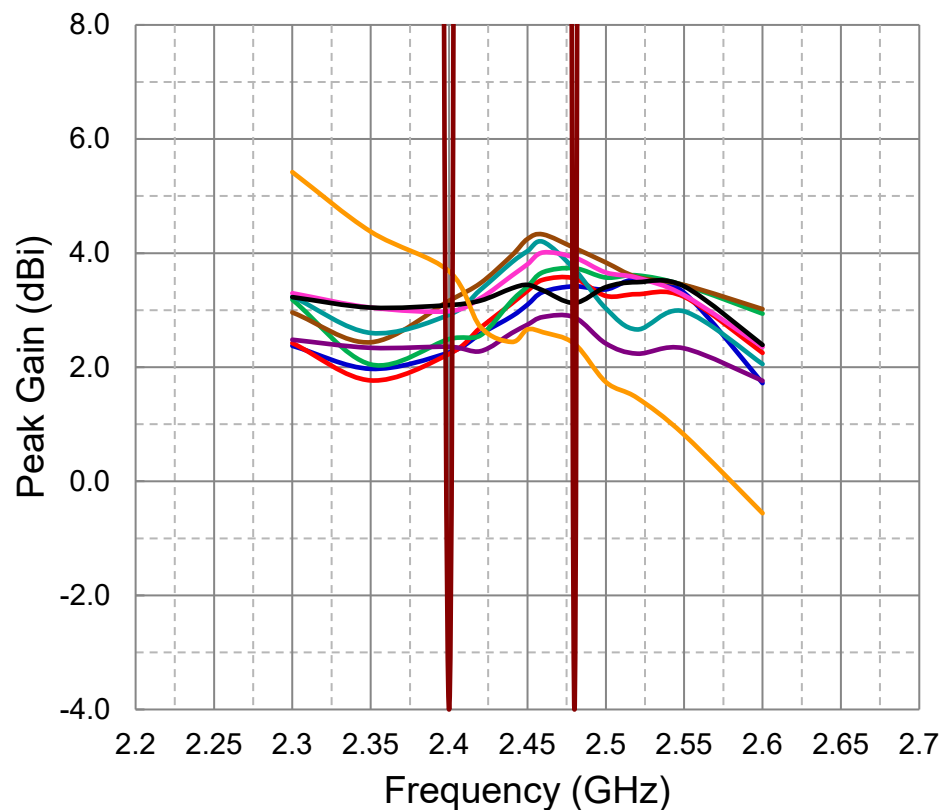
Efficiency Directional Beam



— Beam1 — Beam2 — Beam3 — Beam4 — Beam5
— Beam6 — Beam7 — Beam8 — Beam9 —

2.4GHz	Max	Mean	Min
Beam 1	15 %	14 %	13 %
Beam 2	16 %	14 %	12 %
Beam 3	17 %	16 %	14 %
Beam 4	15 %	14 %	13 %
Beam 5	17 %	16 %	14 %
Beam 6	17 %	15 %	14 %
Beam 7	17 %	16 %	15 %
Beam 8	16 %	15 %	14 %
Beam 9	32 %	27 %	24 %

Peak Gain Directional Beam

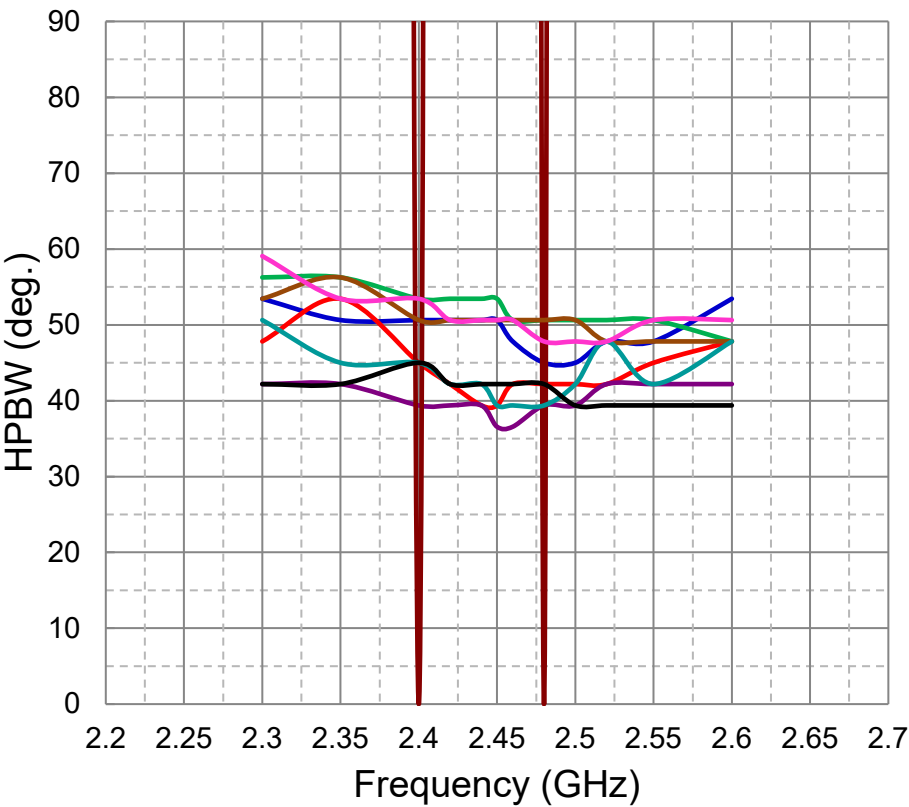


— Beam1 — Beam2 — Beam3 — Beam4 — Beam5
— Beam6 — Beam7 — Beam8 — Beam9 —

2.4GHz	Max	Mean	Min
Beam 1	3.4 dBi	2.9 dBi	2.3 dBi
Beam 2	3.6 dBi	3.1 dBi	2.2 dBi
Beam 3	3.7 dBi	3.2 dBi	2.5 dBi
Beam 4	2.9 dBi	2.6 dBi	2.3 dBi
Beam 5	4.3 dBi	3.9 dBi	3.2 dBi
Beam 6	4.2 dBi	3.7 dBi	2.9 dBi
Beam 7	4.0 dBi	3.6 dBi	3.0 dBi
Beam 8	3.4 dBi	3.3 dBi	3.1 dBi
Beam 9	3.7 dBi	2.8 dBi	2.4 dBi

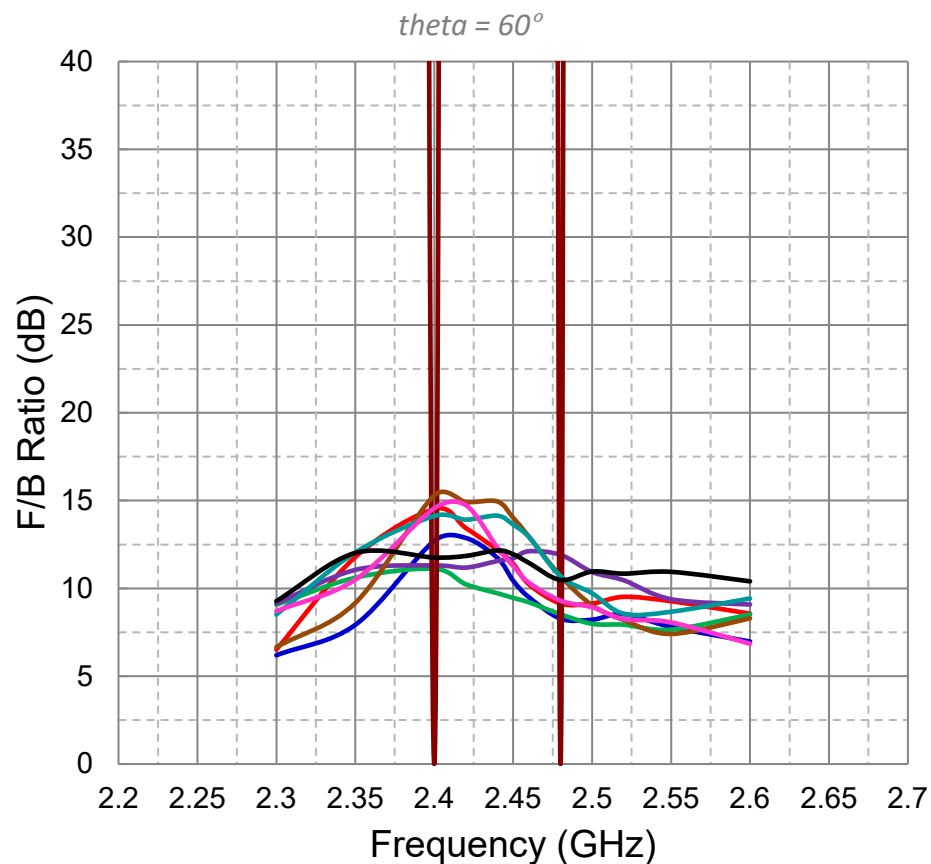
3dB Beam Width Directional Beam

$\theta = 60^\circ$



2.4GHz	Max	Mean	Min
Beam 1	51	49	45
Beam 2	45	42	39
Beam 3	53	53	51
Beam 4	39	38	37
Beam 5	51	51	51
Beam 6	45	41	39
Beam 7	53	51	48
Beam 8	45	43	42
Summary	53	46	37

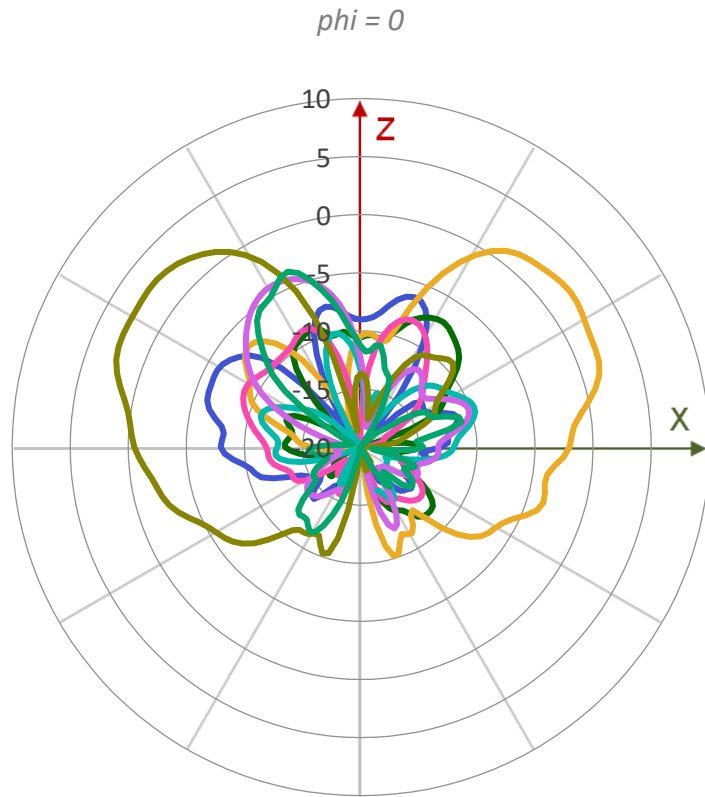
Front to Back Ratio Directional Beam



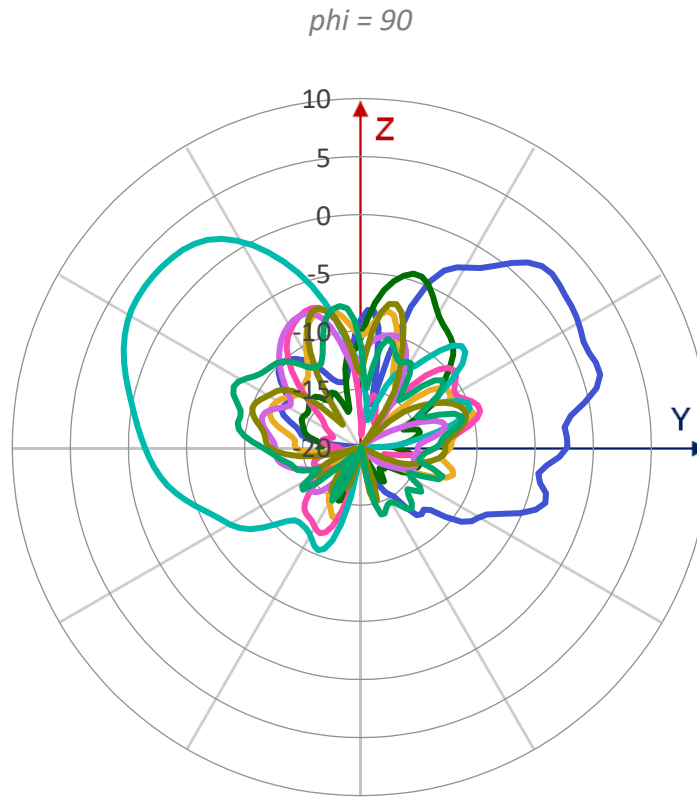
2.4GHz	Max	Mean	Min
Beam 1	12.9	10.9	8.3
Beam 2	14.5	11.8	9.1
Beam 3	11.1	9.7	8.5
Beam 4	12.1	11.6	11.2
Beam 5	15.3	13.8	10.7
Beam 6	14.1	13.2	10.7
Beam 7	14.7	12.1	9.3
Beam 8	12.2	11.6	10.5
Summary	15.3	11.8	8.3

Realized Gain Pattern

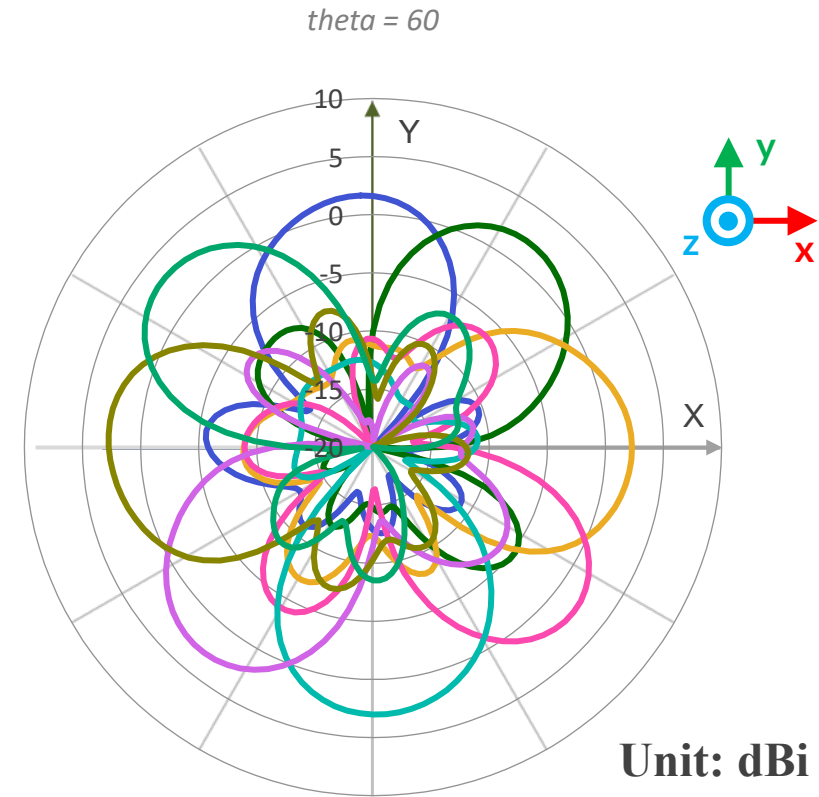
Directional Beam 1-8 @2400MHz for G_{total}



— Beam1 — Beam2 — Beam3 — Beam4
— Beam5 — Beam6 — Beam7 — Beam8



— Beam1 — Beam2 — Beam3 — Beam4
— Beam5 — Beam6 — Beam7 — Beam8

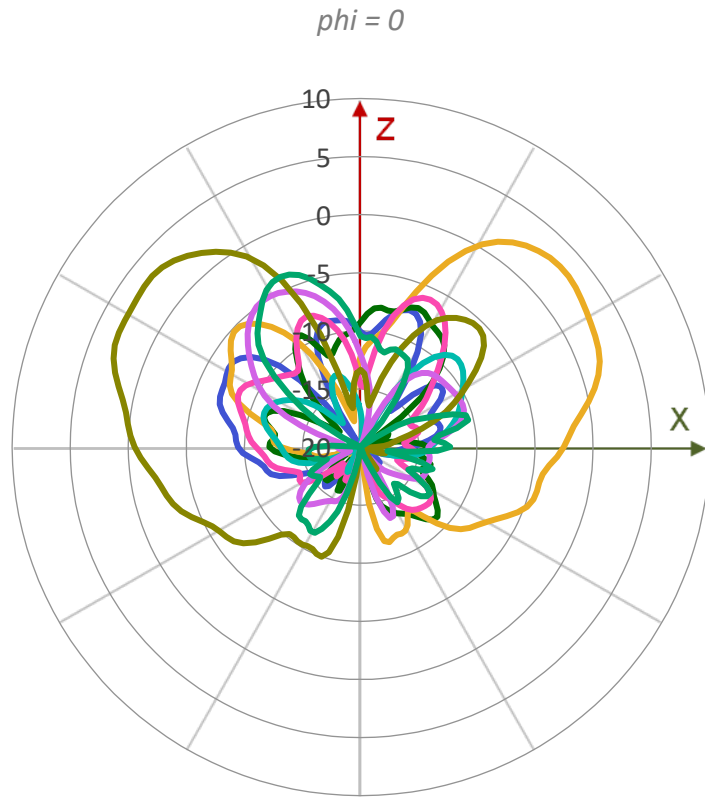


Unit: dBi

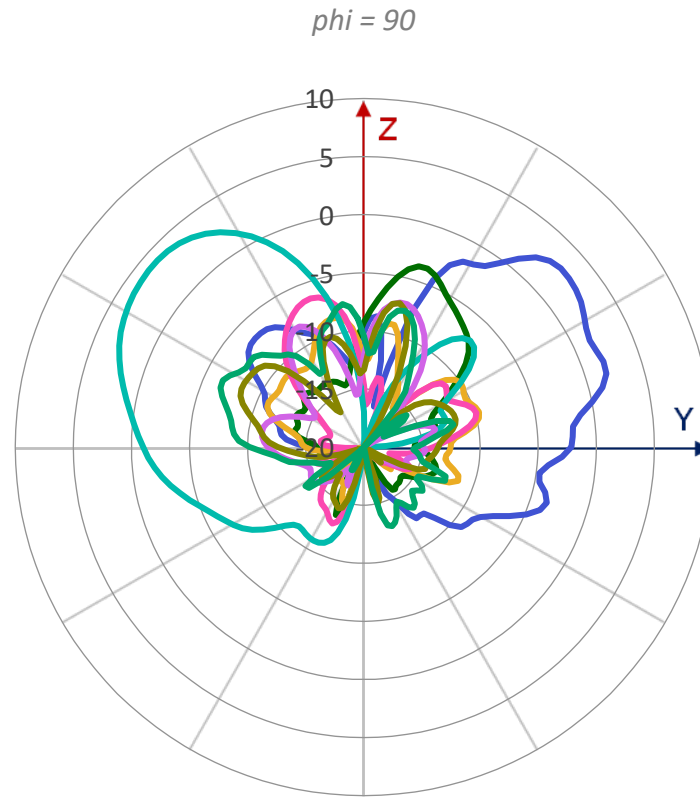
— Beam1 — Beam2 — Beam3 — Beam4
— Beam5 — Beam6 — Beam7 — Beam8

Realized Gain Pattern

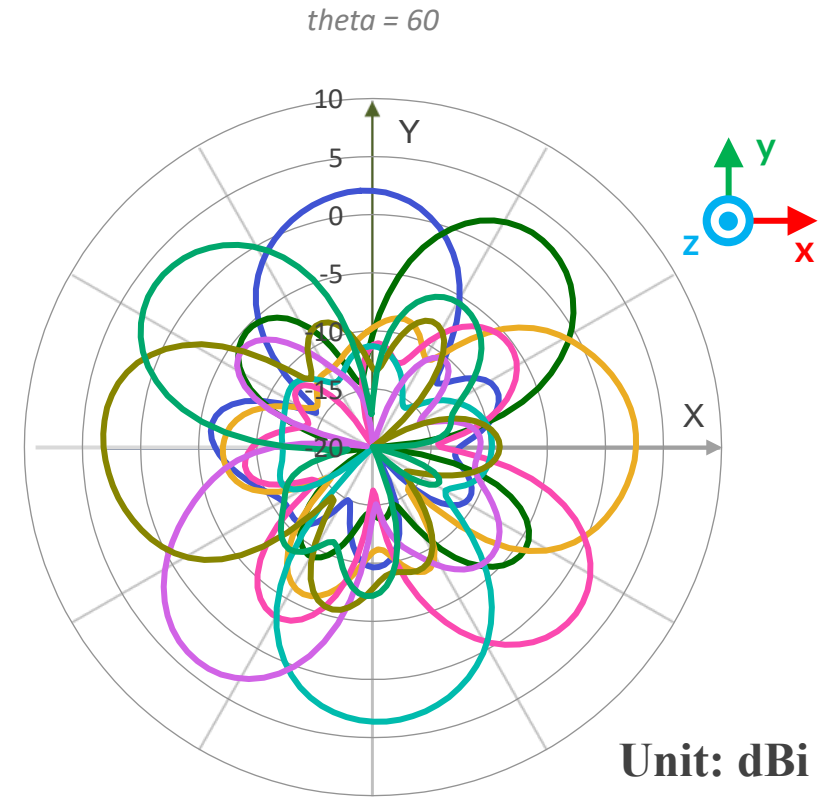
Directional Beam 1-8 @2440MHz for G_{total}



— Beam1 — Beam2 — Beam3 — Beam4
— Beam5 — Beam6 — Beam7 — Beam8



— Beam1 — Beam2 — Beam3 — Beam4
— Beam5 — Beam6 — Beam7 — Beam8

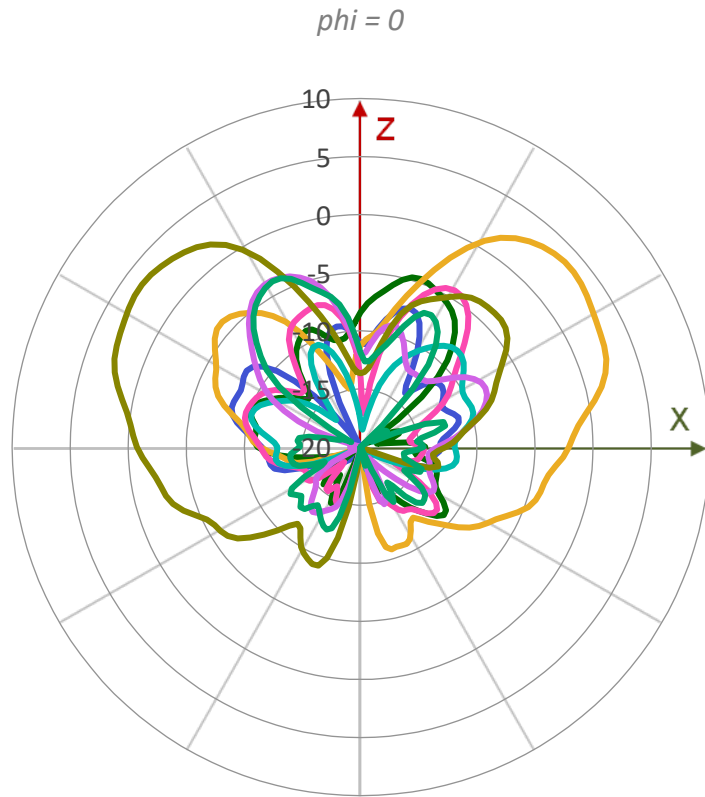


Unit: dBi

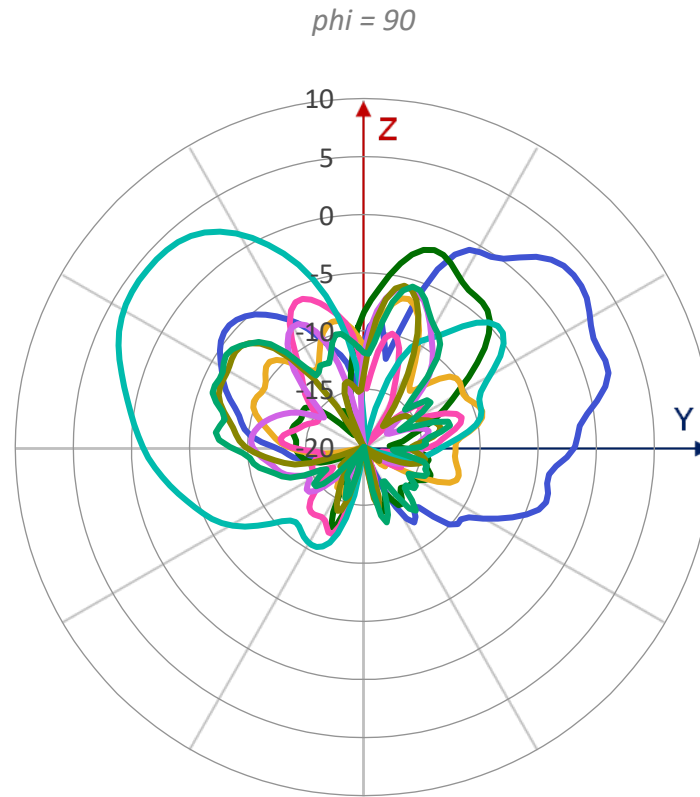
— Beam1 — Beam2 — Beam3 — Beam4
— Beam5 — Beam6 — Beam7 — Beam8

Realized Gain Pattern

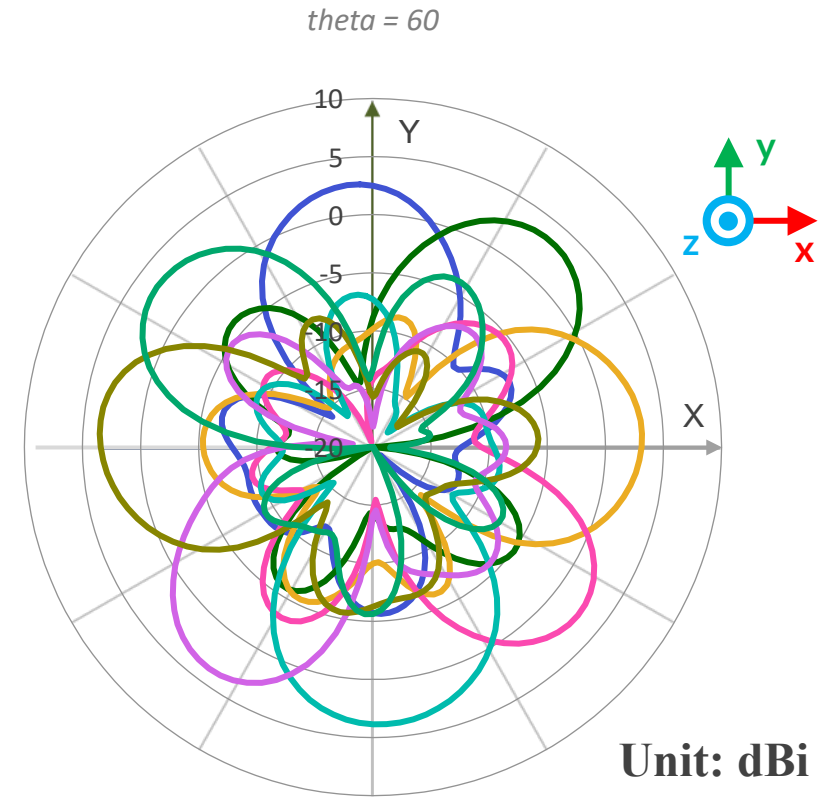
Directional Beam 1-8 @2480MHz for G_{total}



— Beam1 — Beam2 — Beam3 — Beam4
— Beam5 — Beam6 — Beam7 — Beam8



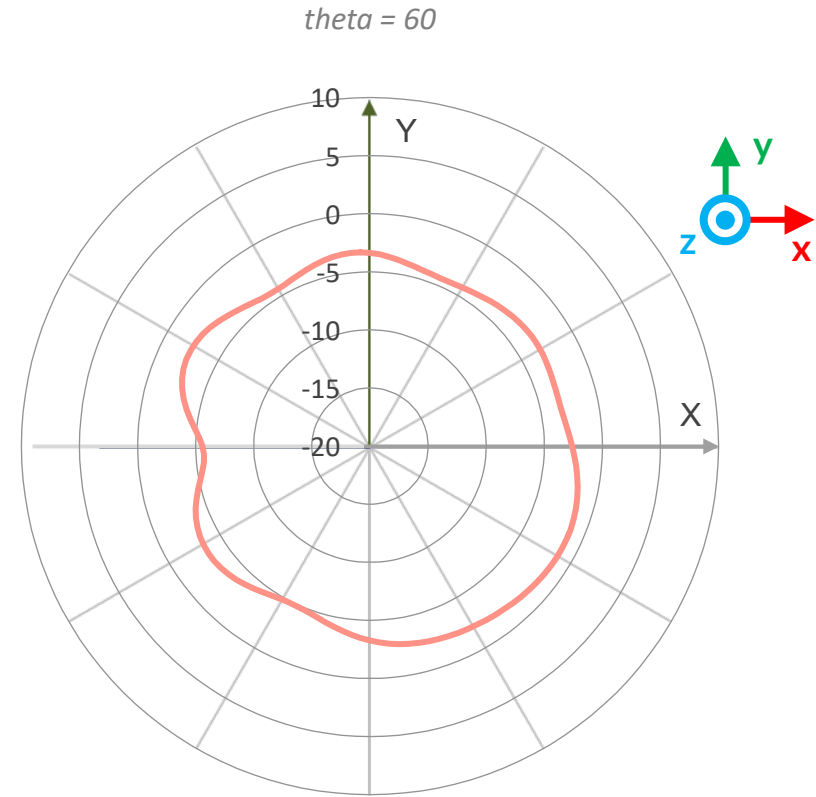
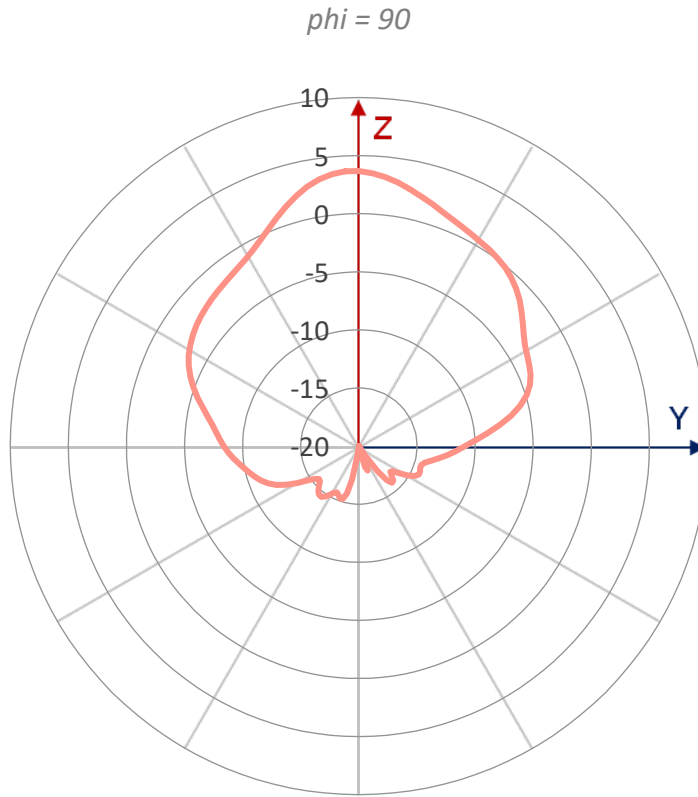
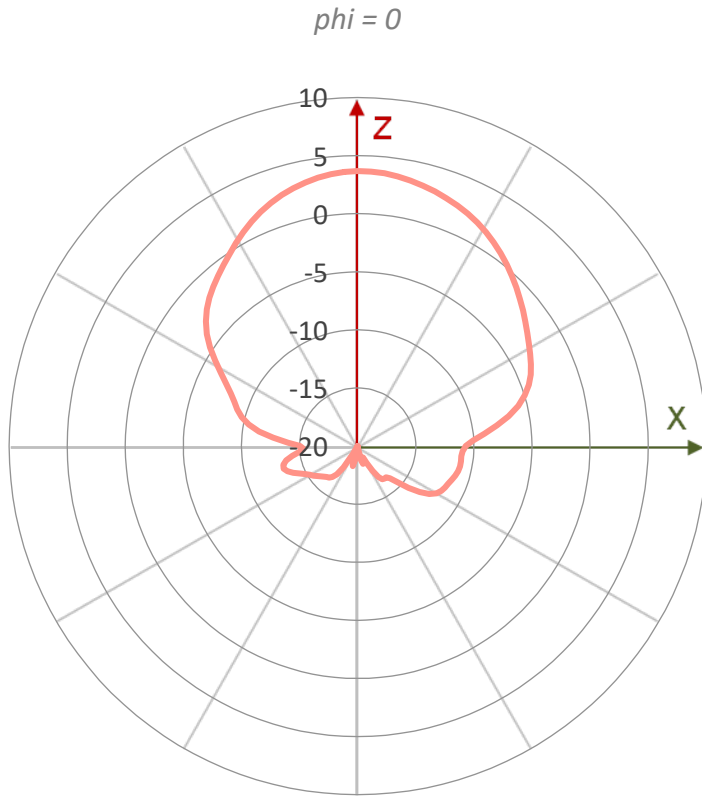
— Beam1 — Beam2 — Beam3 — Beam4
— Beam5 — Beam6 — Beam7 — Beam8



— Beam1 — Beam2 — Beam3 — Beam4
— Beam5 — Beam6 — Beam7 — Beam8

Realized Gain Pattern

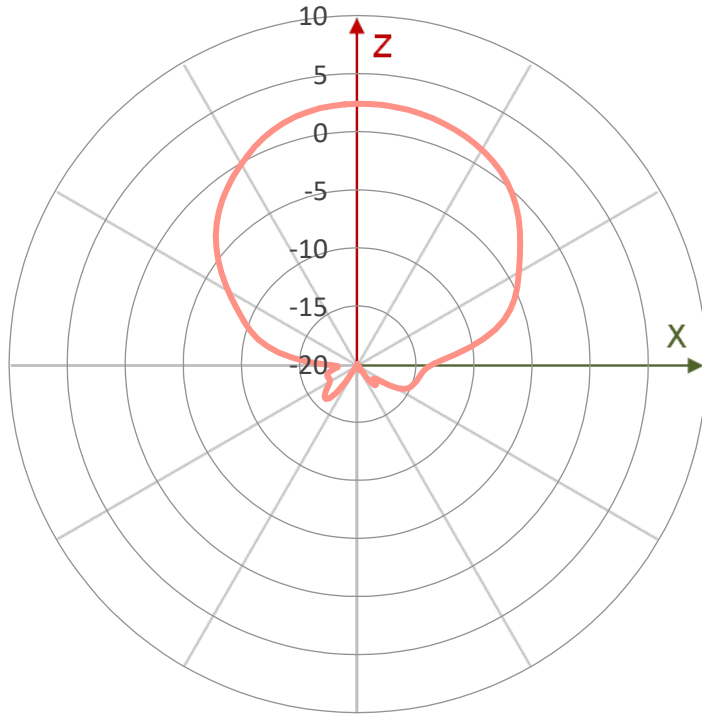
Directional Beam 9 @2400MHz for G_{total}



Realized Gain Pattern

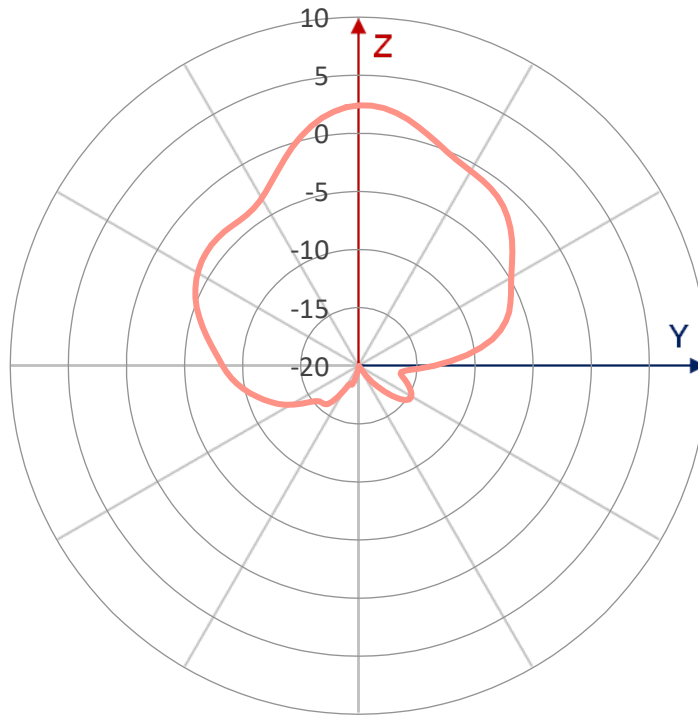
Directional Beam 9 @2440MHz for G_{total}

$\phi = 0$



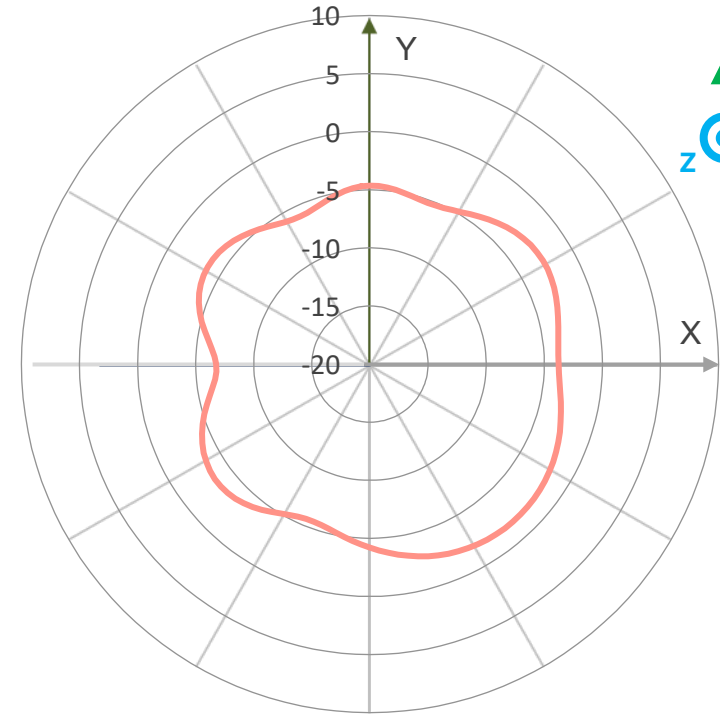
— Beam9

$\phi = 90$



— Beam9

$\theta = 60$

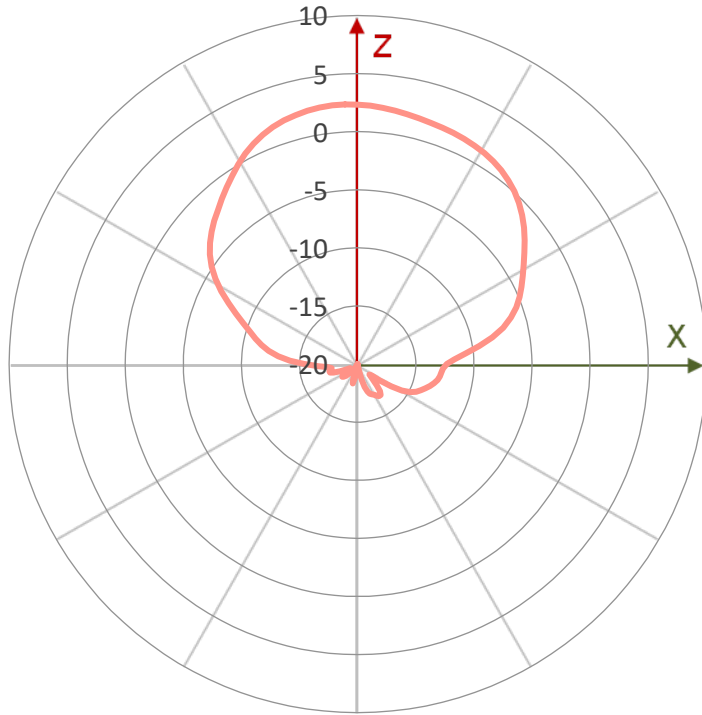


— Beam9

Realized Gain Pattern

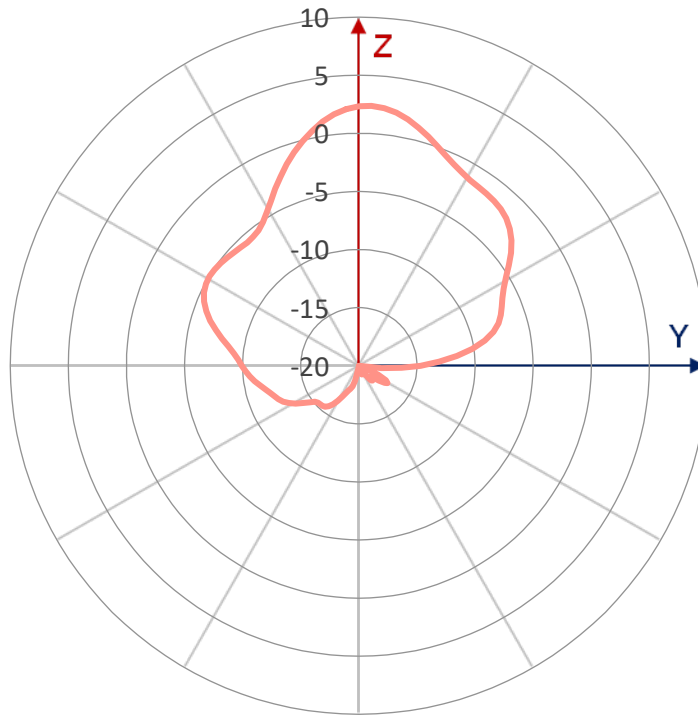
Directional Beam 9 @2480MHz for G_{total}

$\phi = 0$



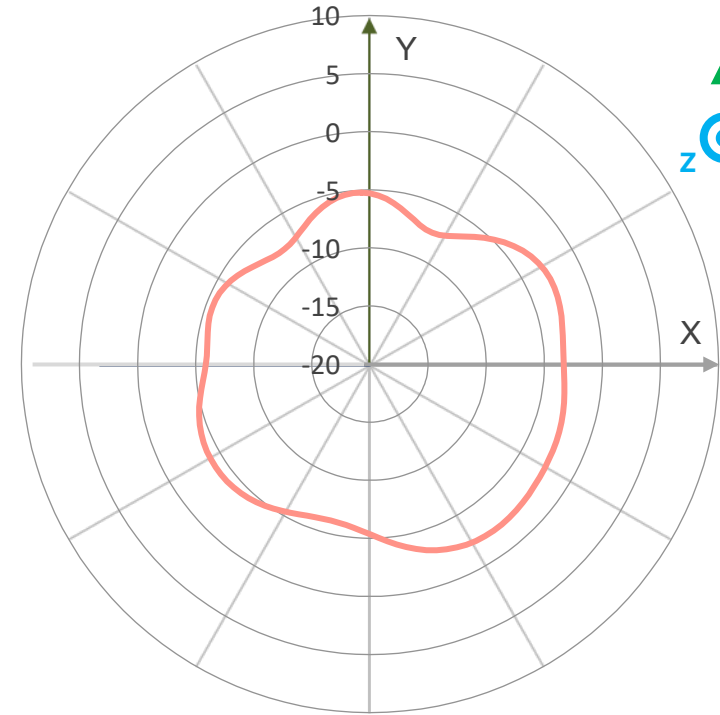
— Beam9

$\phi = 90$

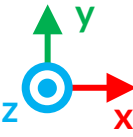


— Beam9

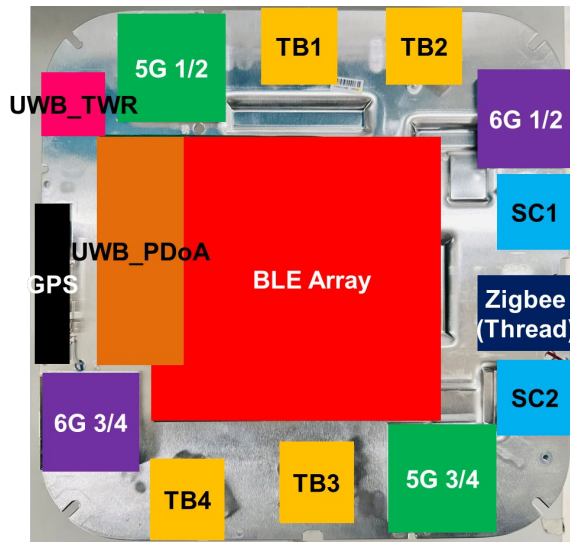
$\theta = 60$



— Beam9



BLE Array – Omni Beam



- **Maximum VSWR**

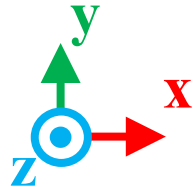
- 1.5 on 2.4GHz

- **Efficiency**

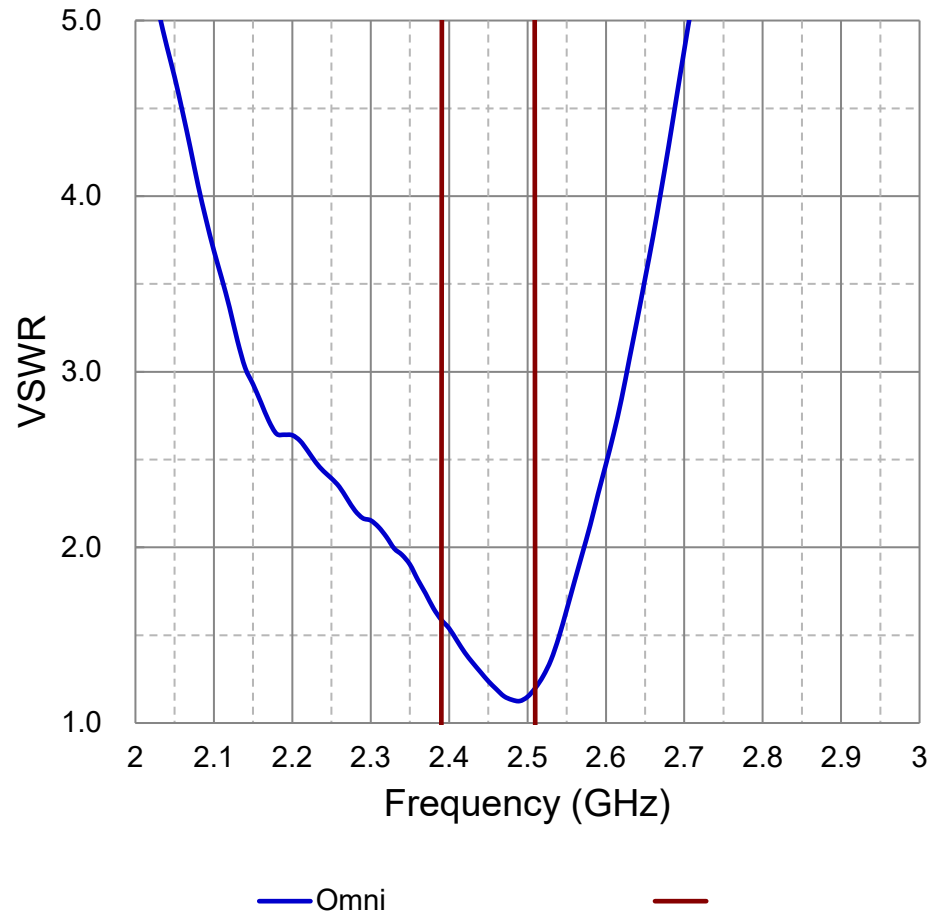
- ~20% on 2.4GHz

- **Peak Gain**

- 0.2 dBi on 2.4GHz

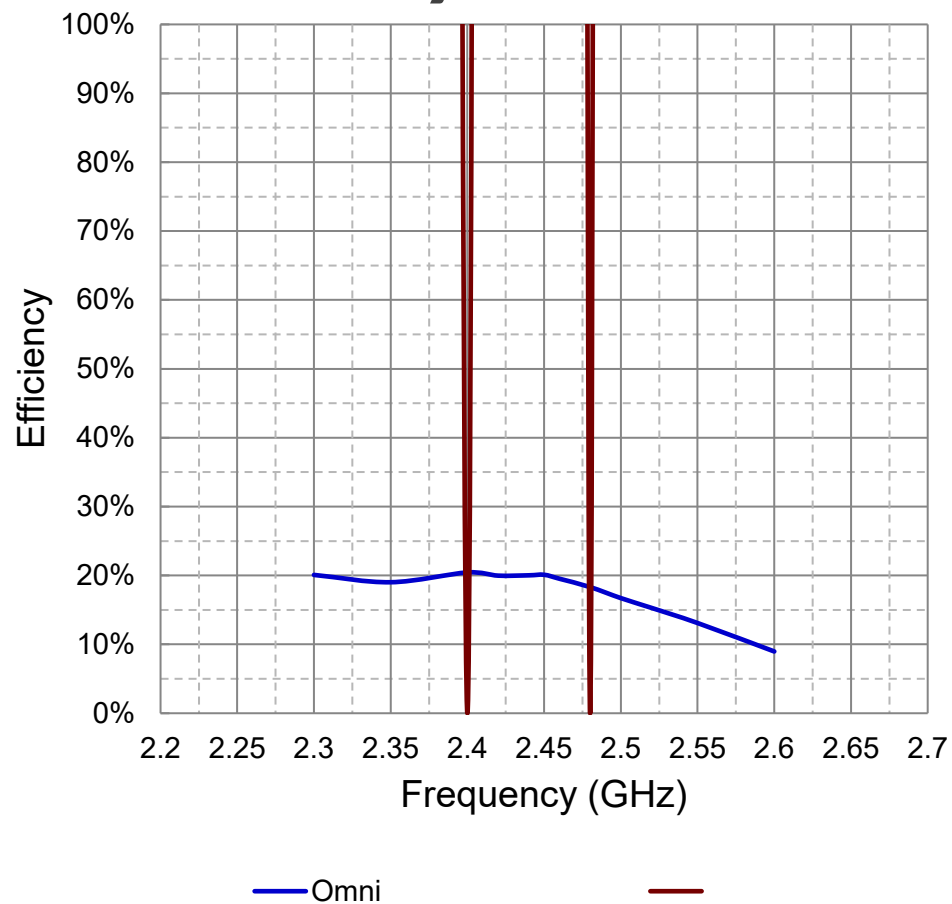


VSWR Omni Beam



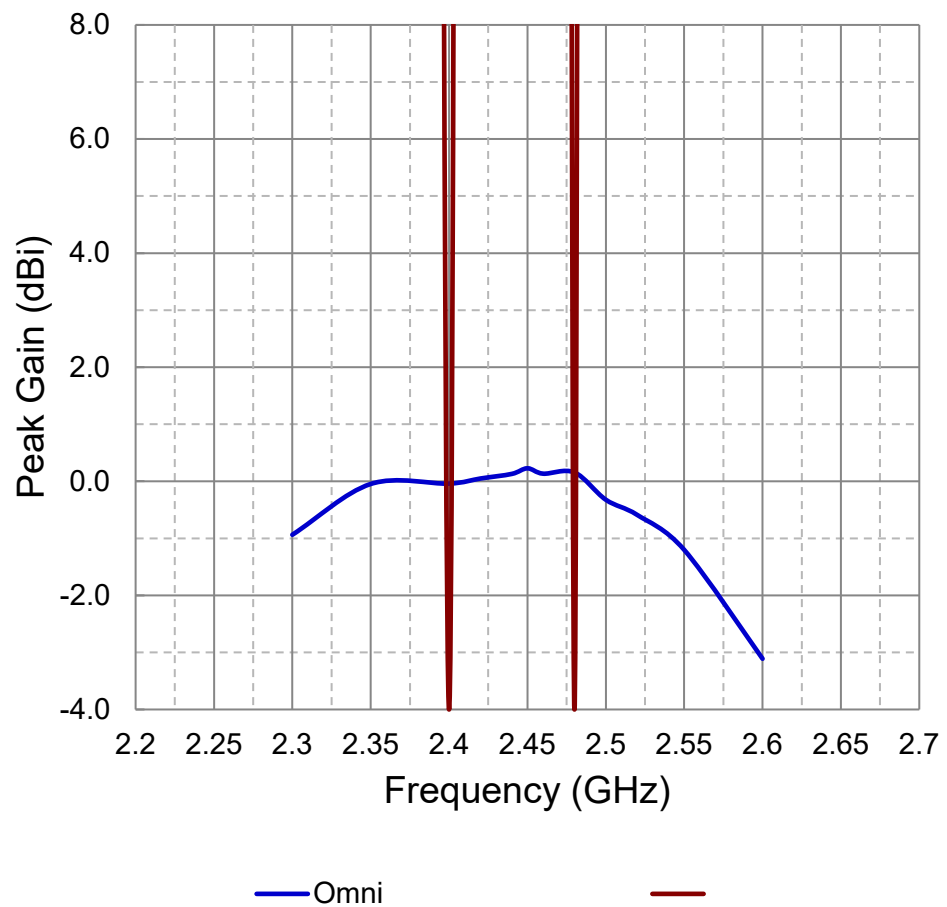
2.4GHz	Max	Mean	Min
Omni	1.5	1.3	1.1

Efficiency Omni Beam



2.4GHz	Max	Mean	Min
Omni	20 %	20 %	18 %

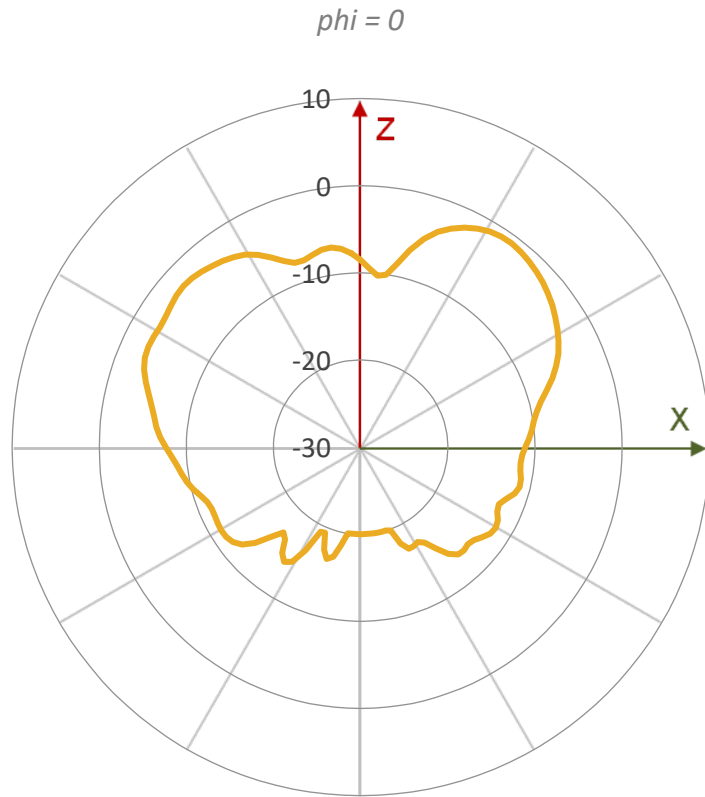
Peak Gain **Omni Beam**



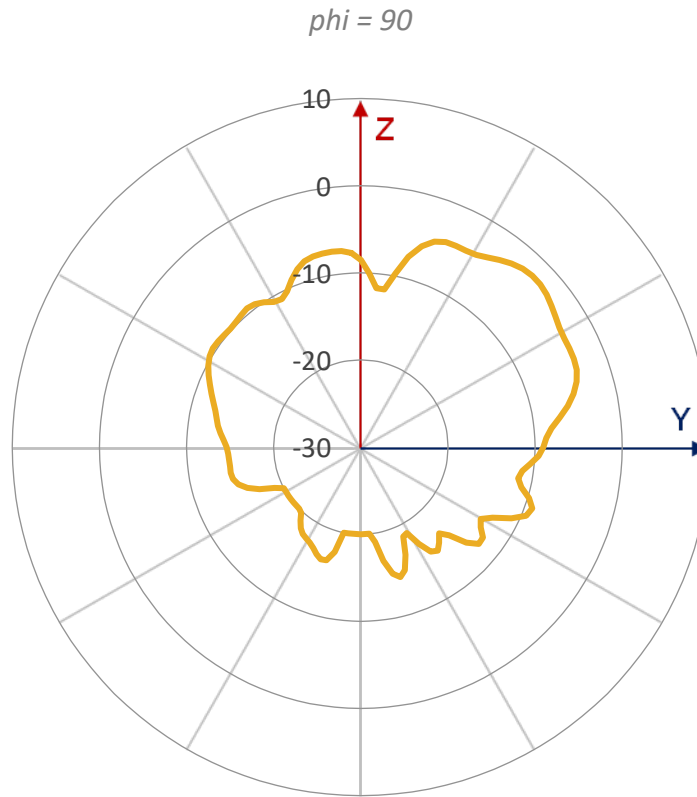
2.4GHz	Max	Mean	Min
Omni	0.2 dBi	0.1 dBi	0.0 dBi

Realized Gain Pattern

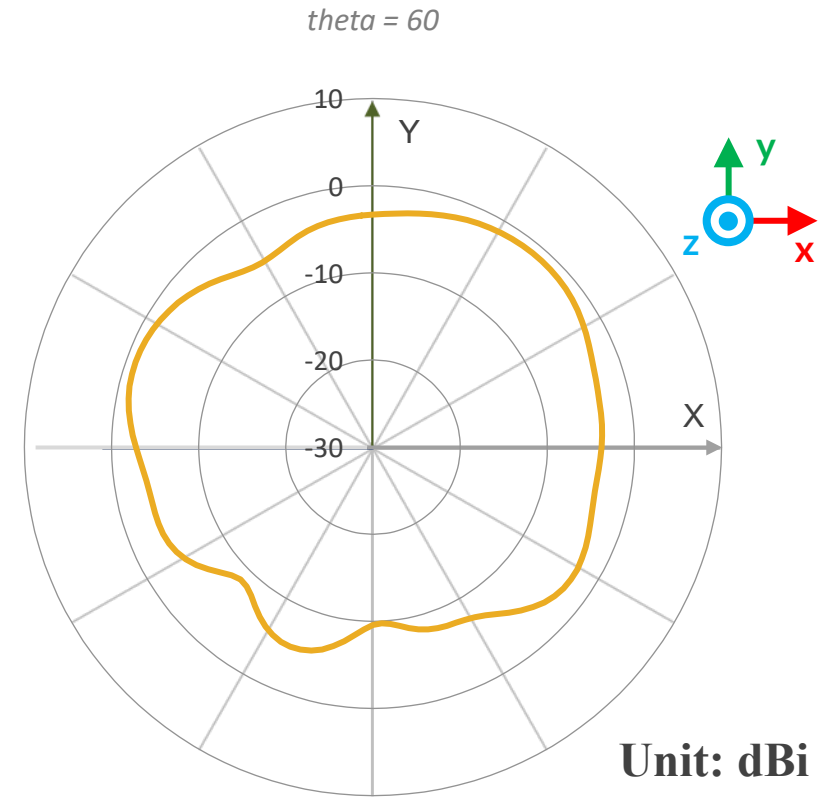
Omni Beam @2440MHz for G_{total}



— Omni



— Omni



— Omni

Unit: dBi