

Jewel AP Antenna Testing Report P2A Sample

Provided by Patrick Tsai

Roye Chen

2021/08/19

Smarter Solutions for a Smarter Future

A blue silhouette of a city skyline is positioned above a wavy blue and green graphic that resembles a road or a data stream. The skyline includes several figures and objects: a person on the left holding a mobile phone with signal waves, a car in the center with a large antenna on its roof, a person walking, a person sitting at a desk with a computer monitor, and another person on the right with a mobile device. The overall theme is smart technology and urban connectivity.

- **2 x Scanning Radio [SC1+SC2] + 4 x 6G [6G1+6G2+6G3++6G4] + 1 x BLE Array**
 - *Antenna Placement*
 - *Summary*
 - *Scanning Radio, 6G WIFI, and BLE Array Antennas*



Summary

The summary antenna performance results shown in below.

- VSWR
 - Under 2 for all antennas except for Slot_directional antenna (under 3.0)
- Radiation efficiency
 - ~57% for 6GHz Single 6G antennas [6G1, 6G2, 6G3, 6G4]
 - ~70% for 2.4GHz Scanning antenna; ~66% for 5GHz Scanning antenna [SC1, SC2]
 - ~22.2% for 2.4GHz BLE array [Beam1~Beam8]; ~34.4% for 2.4GHz BLE slot_directional antenna [Beam9]
 - ~28.4% for 2.4GHz BLE array [Omni]
- Peak gain
 - 5.9dBi for 6GHz Single 6G antennas [6G1, 6G2, 6G3, 6G4]
 - 5.0dBi for 2.4GHz Scanning antenna; 5.8dBi for 5GHz Scanning antenna [SC1, SC2]
 - 4.7dBi for 2.4GHz BLE array [Beam1~Beam8]; 4.5dBi for 2.4GHz BLE slot_directional antenna [Beam9]
 - 1.0dBi for 2.4GHz BLE array [Omni]



Peak Gain Table

| | 5925 MHz | 6565 MHz | 7125 MHz |
|-----------|----------|----------|----------|
| 6G1 | 4.2 dBi | 4.3 dBi | 3.5 dBi |
| 6G2 | 3.6 dBi | 5.0 dBi | 4.1 dBi |
| 6G3 | 3.7 dBi | 4.8 dBi | 4.1 dBi |
| 6G4 | 4.9 dBi | 5.4 dBi | 5.6 dBi |
| Composite | 8.35 dBi | 8.76 dBi | 8.21 dBi |

| | 2450 MHz |
|-----|----------|
| BLE | 4.5dBi |

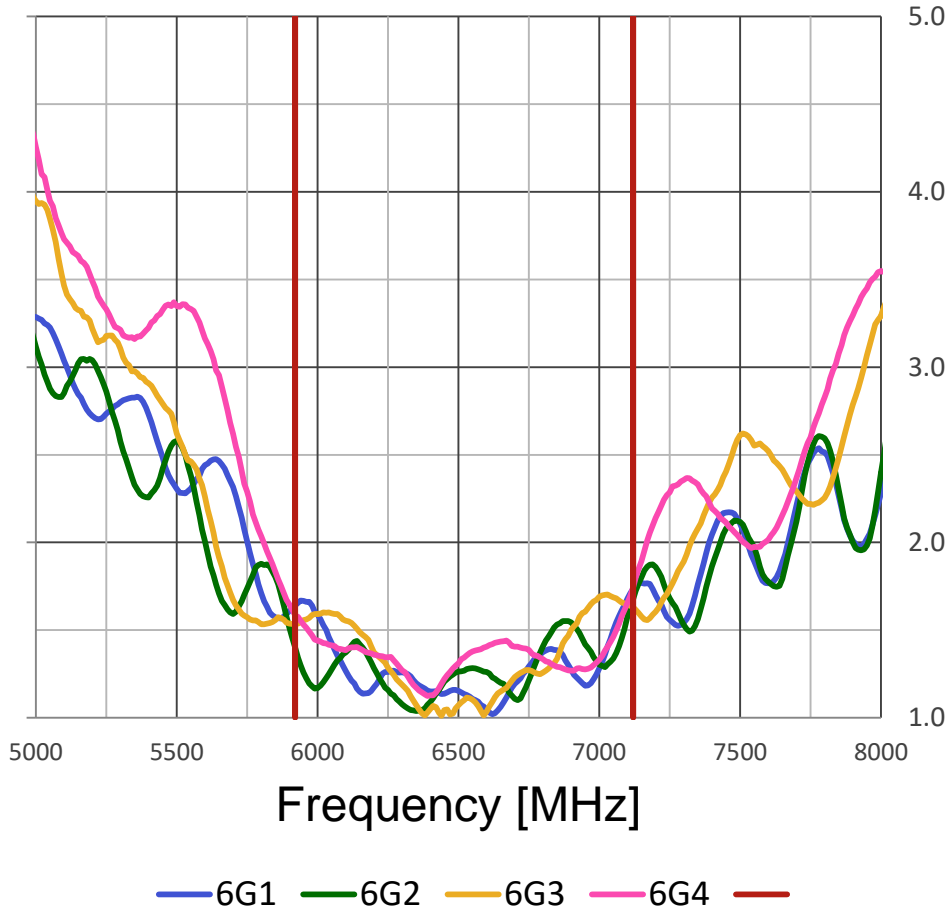
| | 2450 MHz | 5150 MHz | 5450 MHz | 5850 MHz | 5925 MHz | 6565 MHz | 7125 MHz |
|-----------|----------|----------|----------|----------|----------|----------|----------|
| SC1 | 4.2 dBi | 5.4 dBi | 5.0 dBi | 5.1 dBi | 4.7 dBi | 4.8 dBi | 4.1 dBi |
| SC2 | 5.0 dBi | 4.0 dBi | 5.5 dBi | 5.3 dBi | 4.4 dBi | 4.7 dBi | 3.8 dBi |
| Composite | 5.87 dBi | 7.41 dBi | 7.05 dBi | 7.72 dBi | 7.42 dBi | 6.83 dBi | 6.36 dBi |

Single 6G

- **Maximum VSWR**
 - 1.7:1 on 6GHz
- **Minimum Isolation**
 - 34.6dB on 6GHz
- **Efficiency**
 - ~57% on 6GHz
- **Peak Gain**
 - 5.9dBi on 6GHz
- **Cable Length 6G1 :**
302 mm 6G2 : 329mm
6G3 : 160mm 6G4 :
136mm



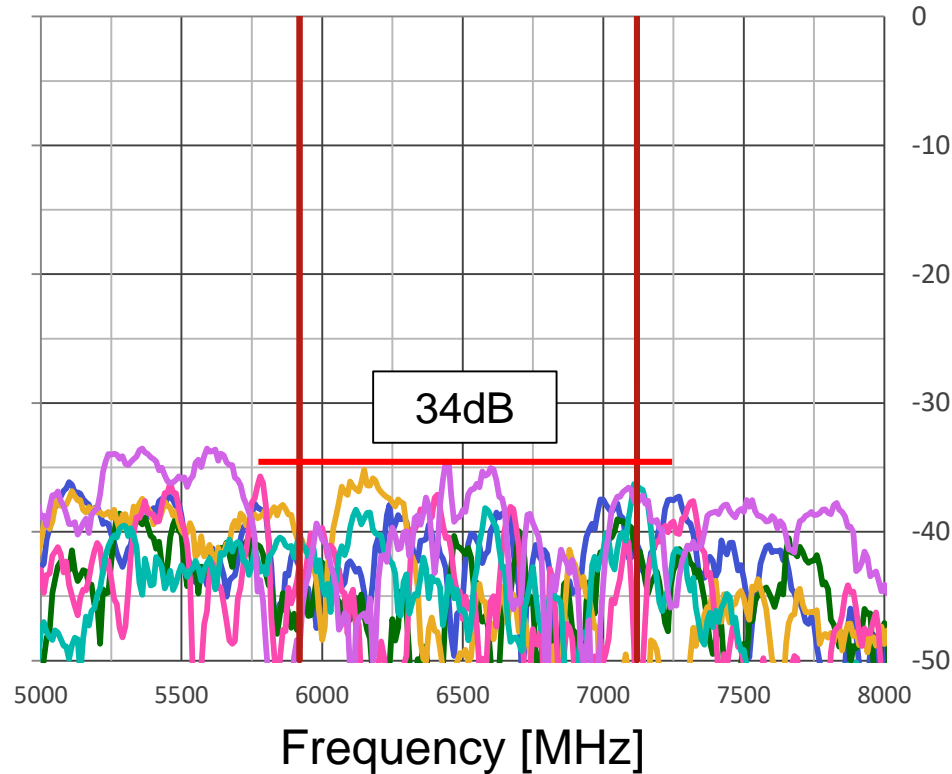
VSWR Single 6G



| 6GHz | Max | Mean | Min |
|---------|-----|------|-----|
| 6G1 | 1.7 | 1.3 | 1.0 |
| 6G2 | 1.7 | 1.3 | 1.0 |
| 6G3 | 1.7 | 1.4 | 1.0 |
| 6G4 | 1.7 | 1.4 | 1.1 |
| Summary | 1.7 | 1.3 | 1.0 |



Isolation Single 6G

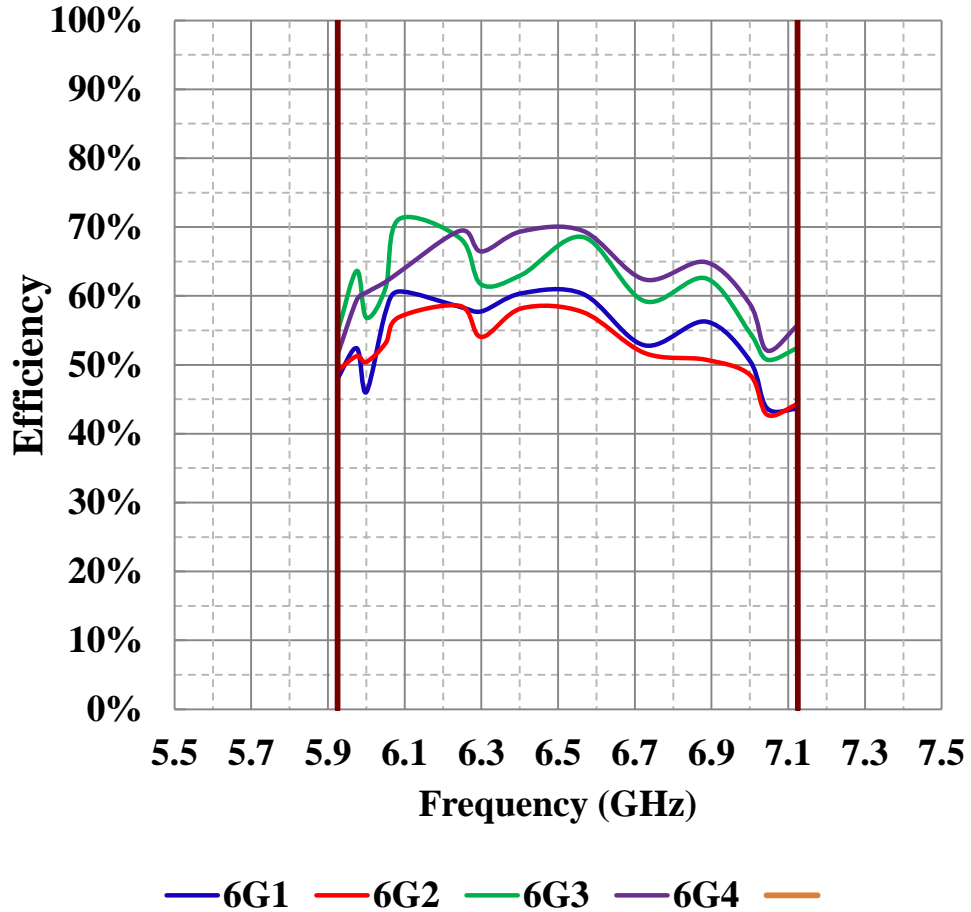


— 6G1_6G2 — 6G1_6G3 — 6G1_6G4 — 6G2_6G3
— 6G2_6G4 — 6G3_6G4 —

| 5GHz | Max | Mean | Min |
|---------|-------|-------|-------|
| 6G1_6G2 | -37.5 | -42.3 | -58.5 |
| 6G1_6G3 | -39.0 | -46.7 | -78.2 |
| 6G1_6G4 | -35.2 | -46.1 | -76.5 |
| 6G2_6G3 | -37.1 | -46.3 | -63.2 |
| 6G2_6G4 | -36.3 | -43.5 | -53.5 |
| 6G3_6G4 | -34.6 | -41.9 | -54.7 |
| Summary | -34.6 | -44.5 | -78.2 |



Efficiency Single 6G



| 6GHz | Max | Mean | Min |
|------|-------|-------|-------|
| 6G1 | 60.6% | 53.5% | 43.6% |
| 6G2 | 58.5% | 52.0% | 42.8% |
| 6G3 | 71.1% | 60.6% | 50.7% |
| 6G4 | 69.5% | 61.8% | 51.5% |

■ Cable Length

6G1 : 302mm

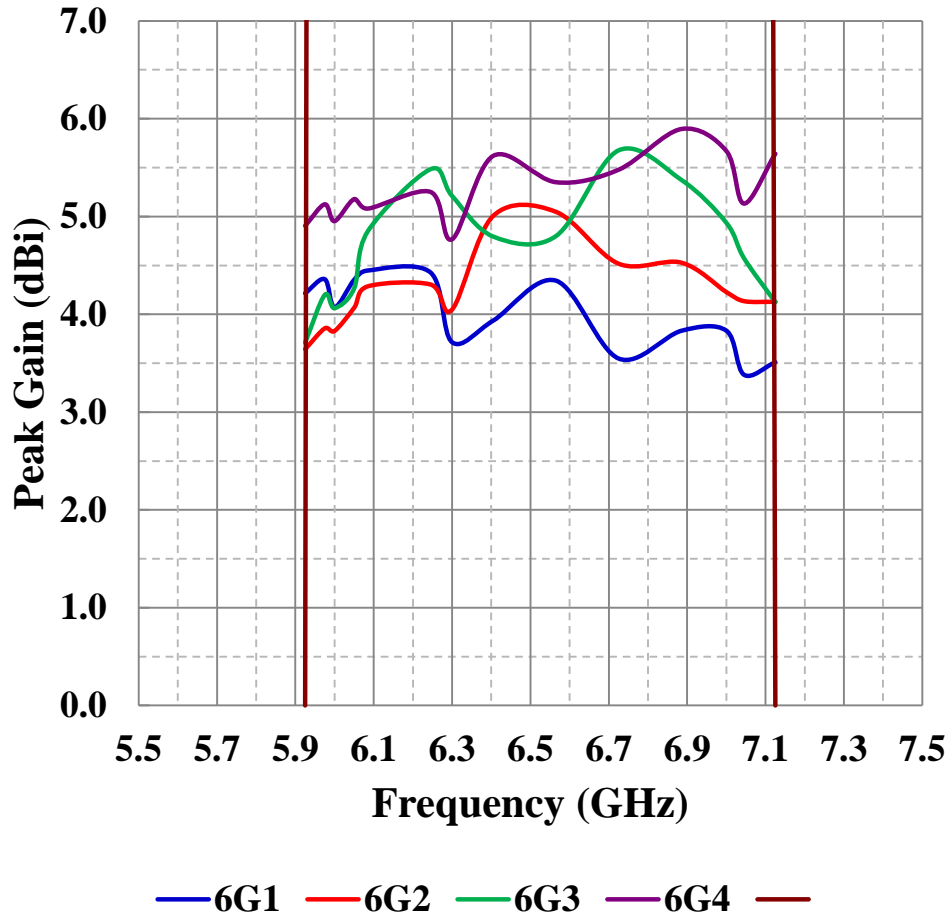
6G2 : 329mm

6G3 : 160mm

6G4 : 136mm



Peak Gain Single 6G

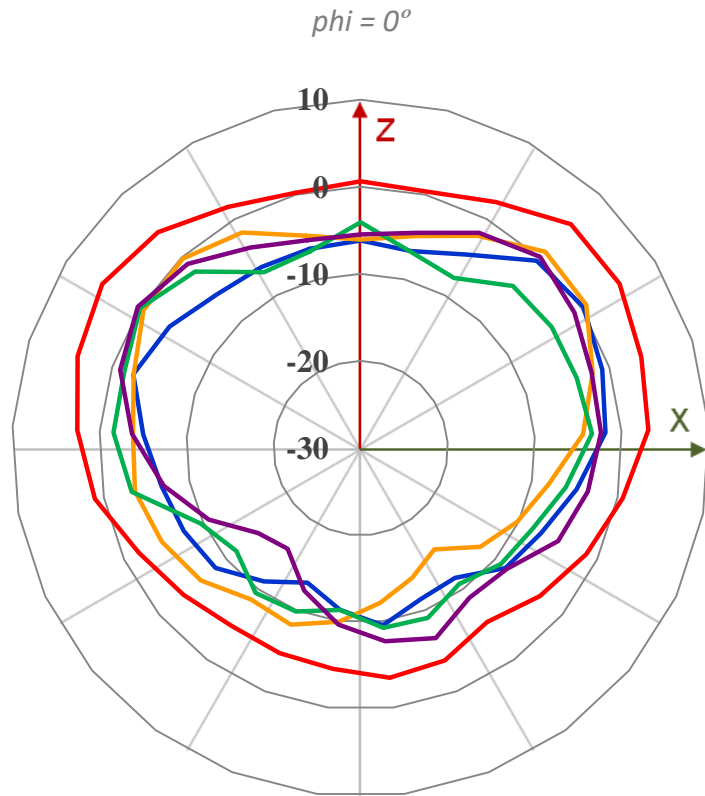


| 6GHz | Max | Mean | Min |
|------|---------|---------|---------|
| 6G1 | 4.4 dBi | 4.0 dBi | 3.4 dBi |
| 6G2 | 5.0 dBi | 4.3 dBi | 3.6 dBi |
| 6G3 | 5.6 dBi | 4.7 dBi | 3.7 dBi |
| 6G4 | 5.9 dBi | 5.3 dBi | 4.9 dBi |

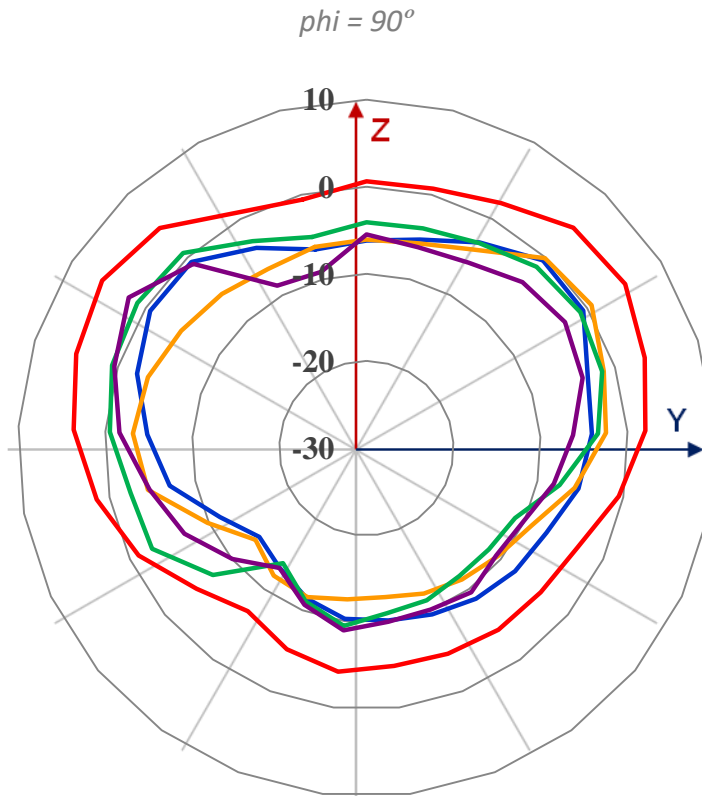
- Cable Length
 - 6G1 : 302mm
 - 6G2 : 329mm
 - 6G3 : 160mm
 - 6G4 : 136mm



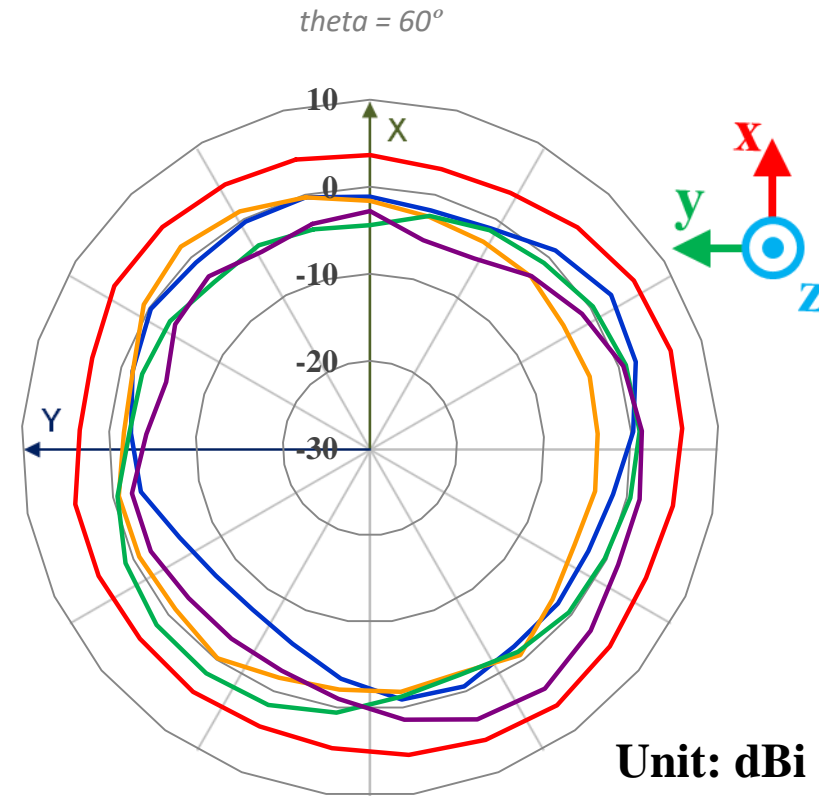
Realized Gain Pattern Single 6G @5925MHz for G_{total}



— 6G1 — 6G2 — 6G3
— 6G4 — Composite



— 6G1 — 6G2 — 6G3
— 6G4 — Composite

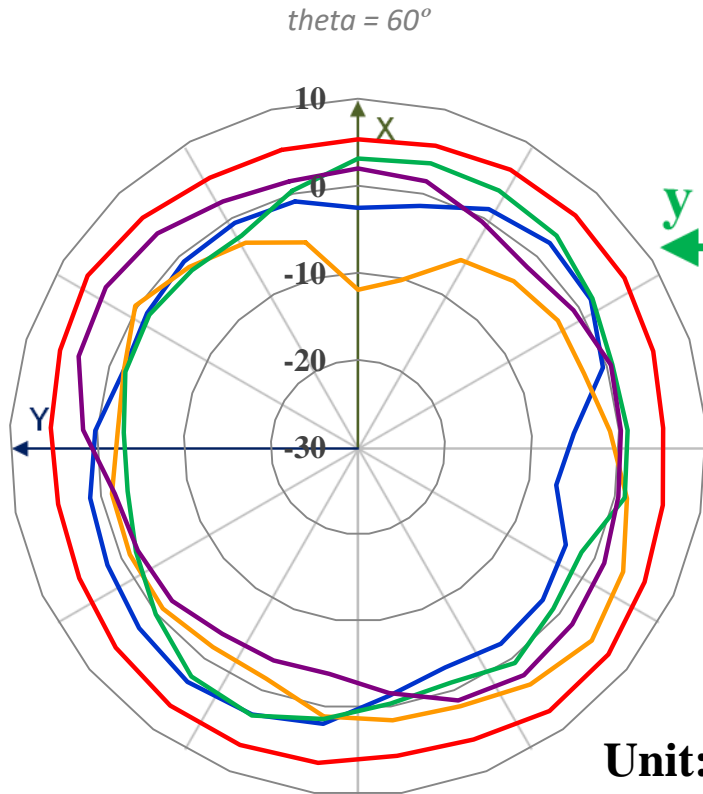
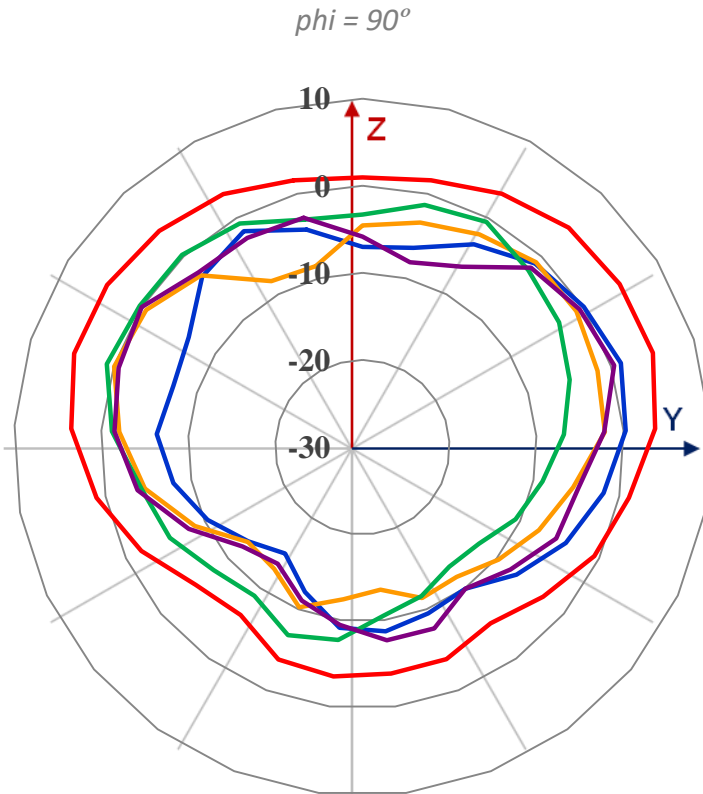


— 6G1 — 6G2 — 6G3
— 6G4 — Composite

Unit: dBi



Realized Gain Pattern Single 6G @6565MHz for G_{total}



Unit: dBi

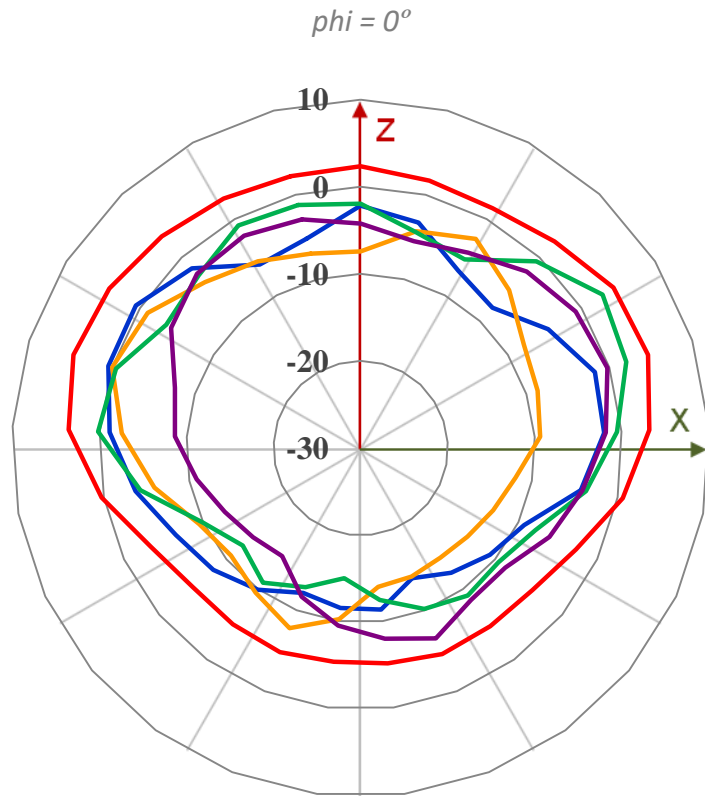
— 6G1 — 6G2 — 6G3
— 6G4 — Composite

— 6G1 — 6G2 — 6G3
— 6G4 — Composite

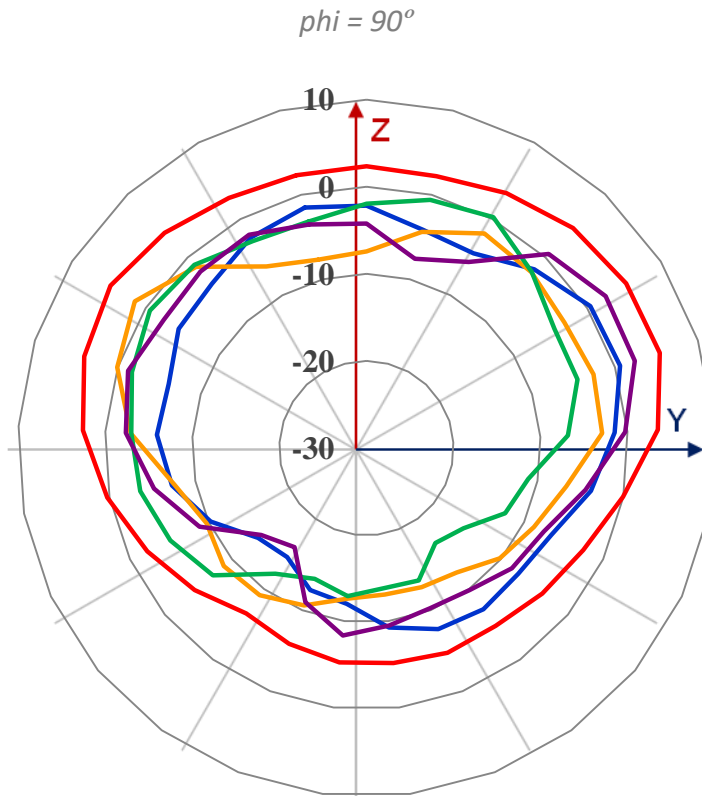
— 6G1 — 6G2 — 6G3
— 6G4 — Composite



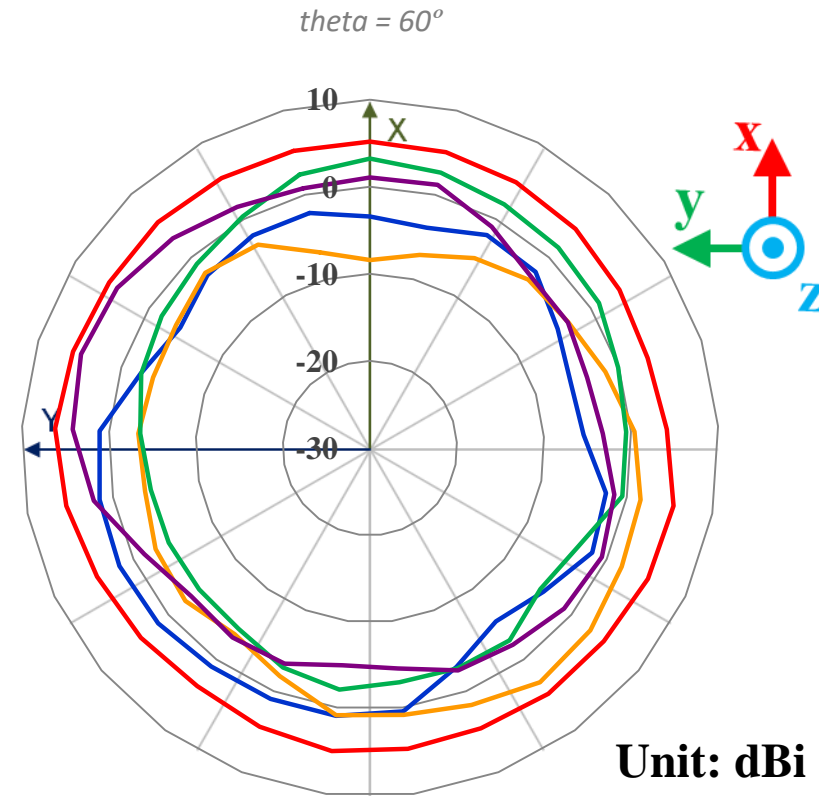
Realized Gain Pattern Single 6G @7125MHz for G_{total}



— 6G1 — 6G2 — 6G3
— 6G4 — Composite



— 6G1 — 6G2 — 6G3
— 6G4 — Composite



— 6G1 — 6G2 — 6G3
— 6G4 — Composite

Unit: dBi



Scanning

- **Maximum VSWR**

- 1.4:1 on 2.4GHz / 1.9:1 on 5GHz

- **Minimum Isolation**

- 23.8dB on 2.4GHz / 32.7dB on 5GHz

- **Average Efficiency**

- ~70% on 2.4GHz / ~67% on 5GHz

- **Peak Gain**

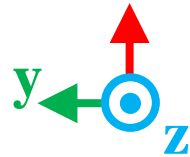
- 5.0dBi on 2.4GHz / 5.8dBi on 5GHz

- **Cable Length**

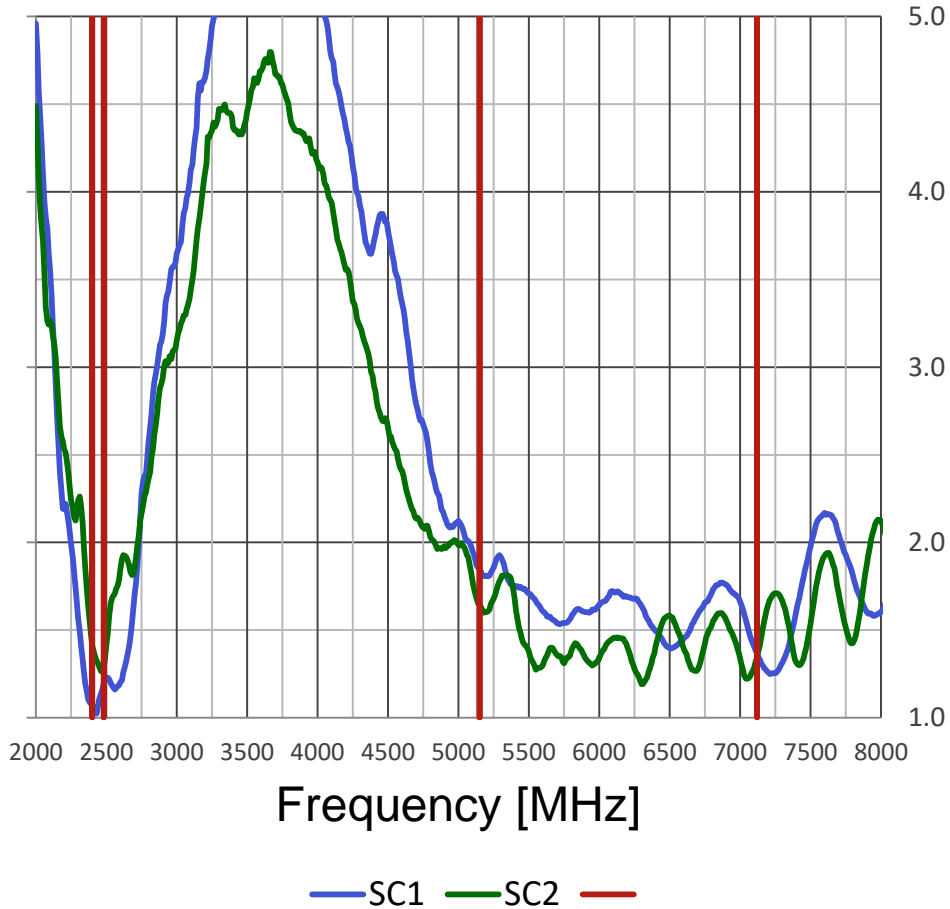
- SC1 : 121 mm

- SC2 : 259mm

X



VSWR Scanning

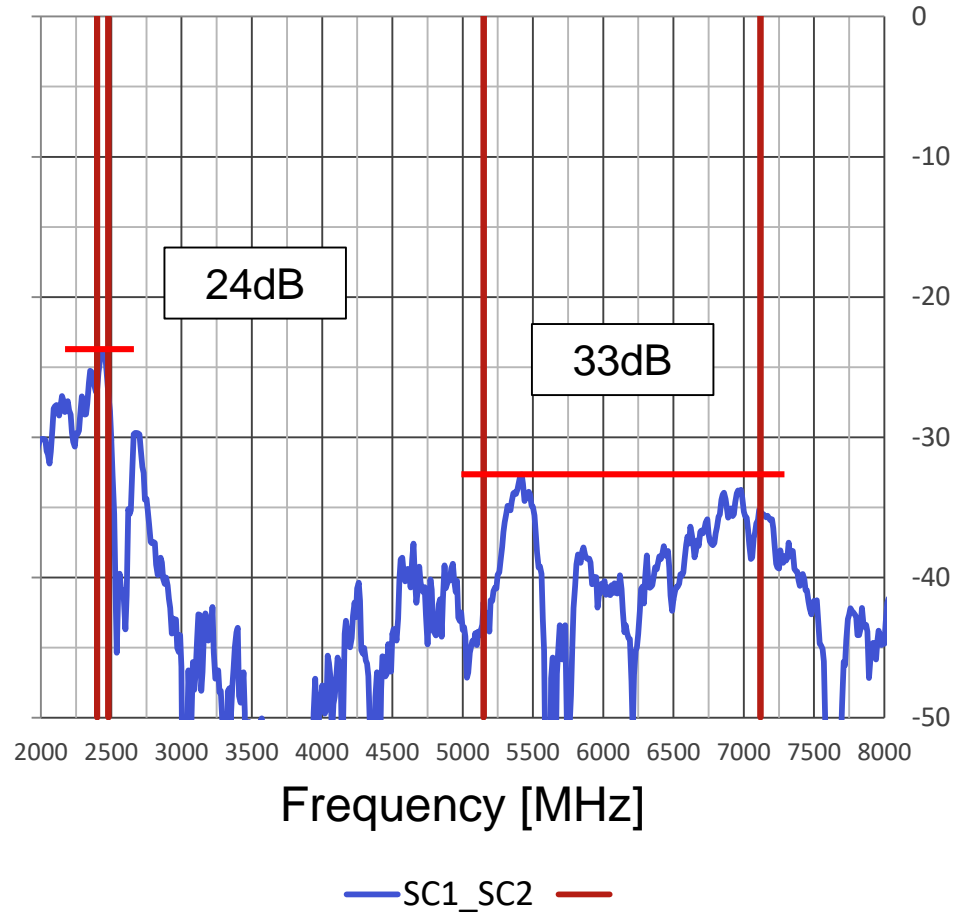


| 2.4GHz | Max | Mean | Min |
|---------|-----|------|-----|
| SC1 | 1.2 | 1.1 | 1.0 |
| SC2 | 1.4 | 1.3 | 1.3 |
| Summary | 1.4 | 1.2 | 1.0 |

| 5_6GHz | Max | Mean | Min |
|---------|-----|------|-----|
| SC1 | 1.9 | 1.6 | 1.4 |
| SC2 | 1.8 | 1.4 | 1.2 |
| Summary | 1.9 | 1.5 | 1.2 |



Isolation Scanning



| 2.4GHz | Max | Mean | Min |
|--------|-----|------|-----|
|--------|-----|------|-----|

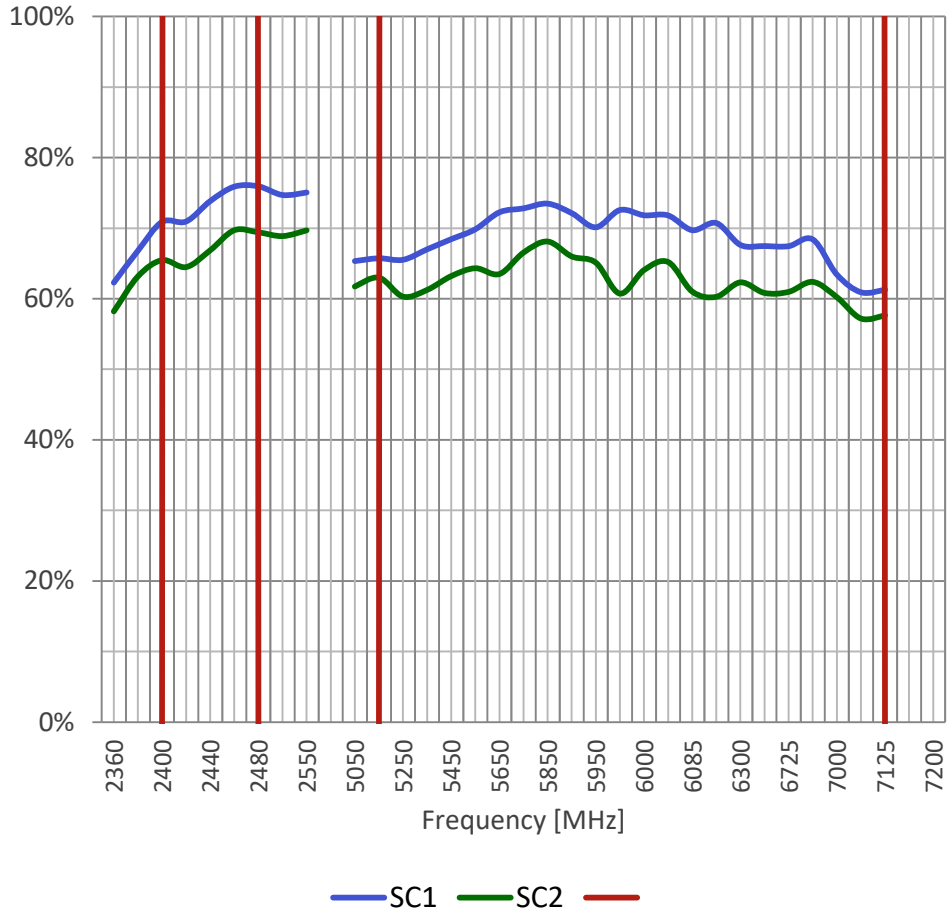
| | | | |
|---------|-------|-------|-------|
| SC1_SC2 | -23.8 | -25.0 | -27.0 |
|---------|-------|-------|-------|

| 5GHz | Max | Mean | Min |
|------|-----|------|-----|
|------|-----|------|-----|

| | | | |
|---------|-------|-------|-------|
| SC1_SC2 | -32.7 | -39.7 | -62.2 |
|---------|-------|-------|-------|



Efficiency Scanning



| 2.4GHz | Max | Mean | Min |
|---------|------|------|------|
| SC1 | 76 % | 74 % | 71 % |
| SC2 | 70 % | 67 % | 64 % |
| Summary | 76 % | 70 % | 64 % |

| 5_6GHz | Max | Mean | Min |
|---------|------|------|------|
| SC1 | 73 % | 69 % | 61 % |
| SC2 | 68 % | 62 % | 57 % |
| Summary | 73 % | 66 % | 57 % |

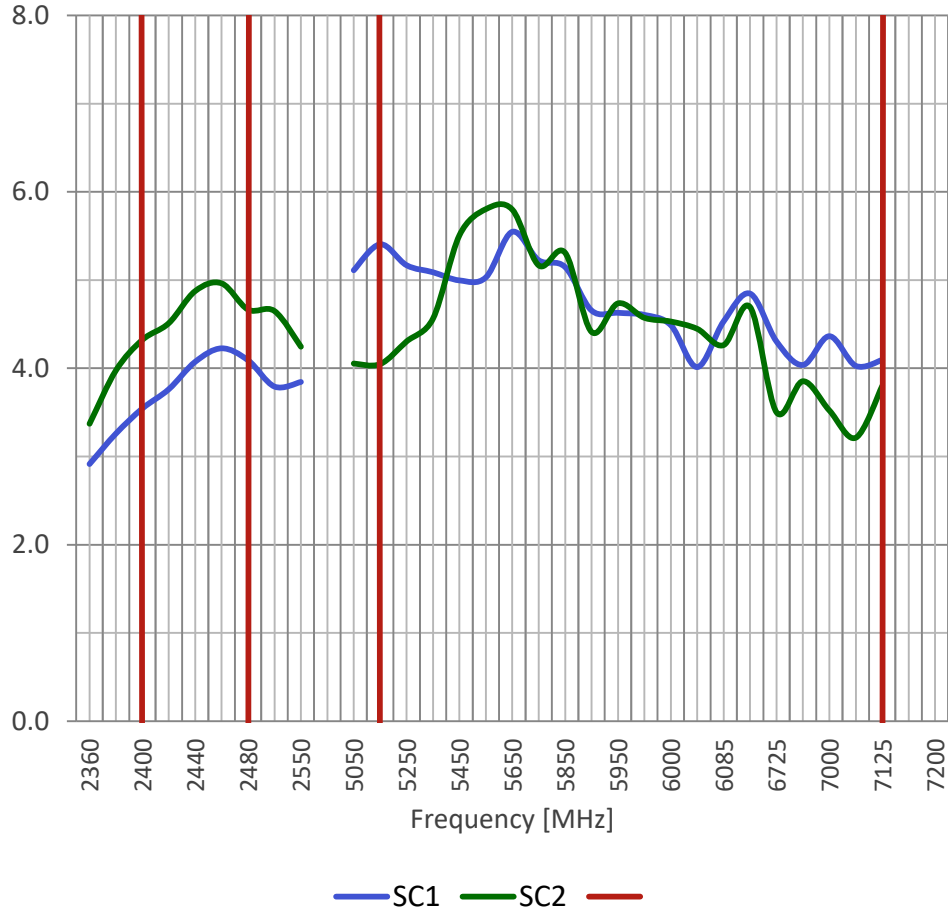
■ Cable Length

SC1 : 121 mm

SC2 : 259mm



Peak Gain Scanning



| 2.4GHz | Max | Mean | Min |
|---------|---------|---------|---------|
| SC1 | 4.2 dBi | 3.9 dBi | 3.5 dBi |
| SC2 | 5.0 dBi | 4.7 dBi | 4.3 dBi |
| Summary | 5.0 dBi | 4.3 dBi | 3.5 dBi |

| 5_6GHz | Max | Mean | Min |
|---------|---------|---------|---------|
| SC1 | 5.5 dBi | 5.2 dBi | 5.0 dBi |
| SC2 | 5.8 dBi | 5.1 dBi | 4.0 dBi |
| Summary | 5.8 dBi | 5.1 dBi | 4.0 dBi |

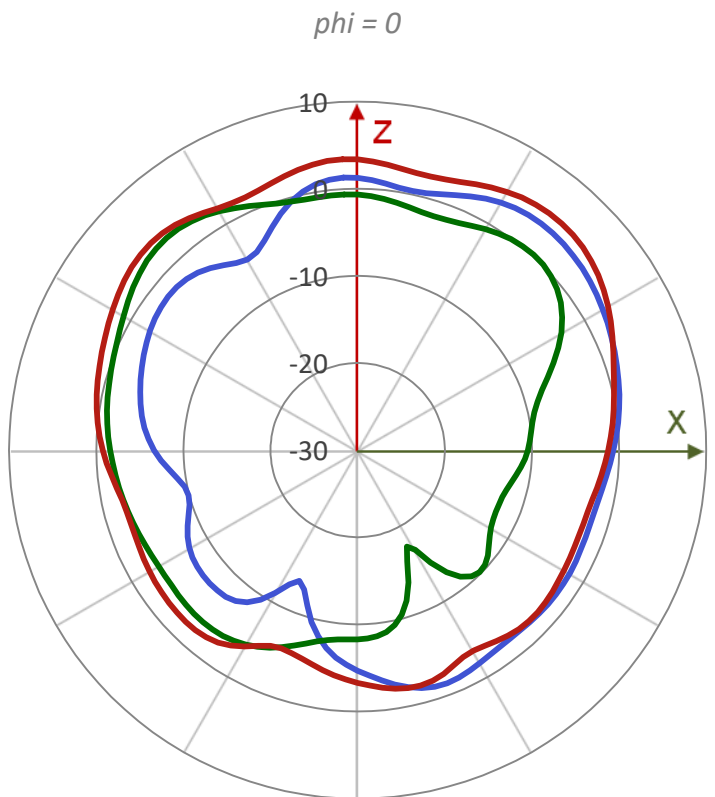
■ **Cable Length**

SC1 : 121 mm

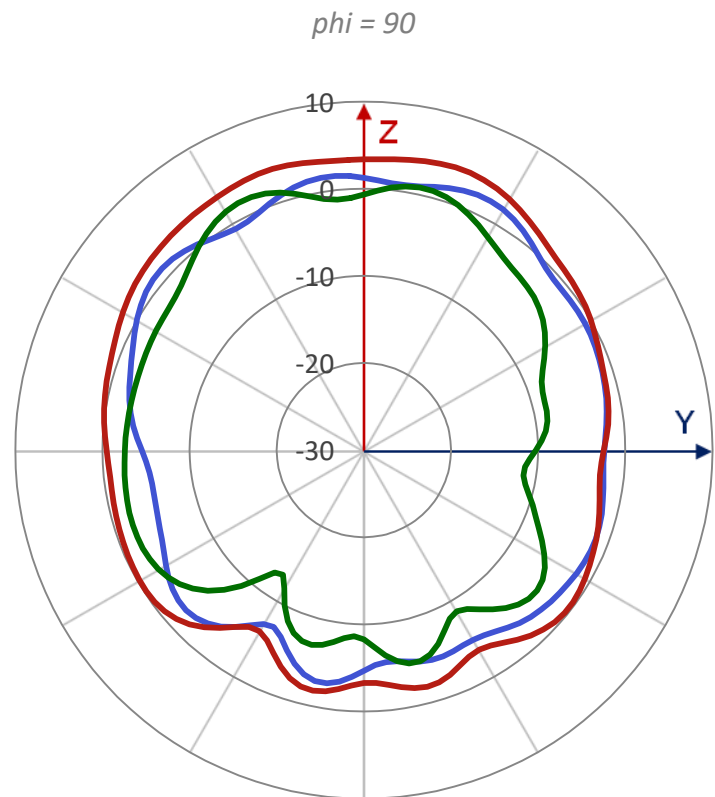
SC2 : 259mm



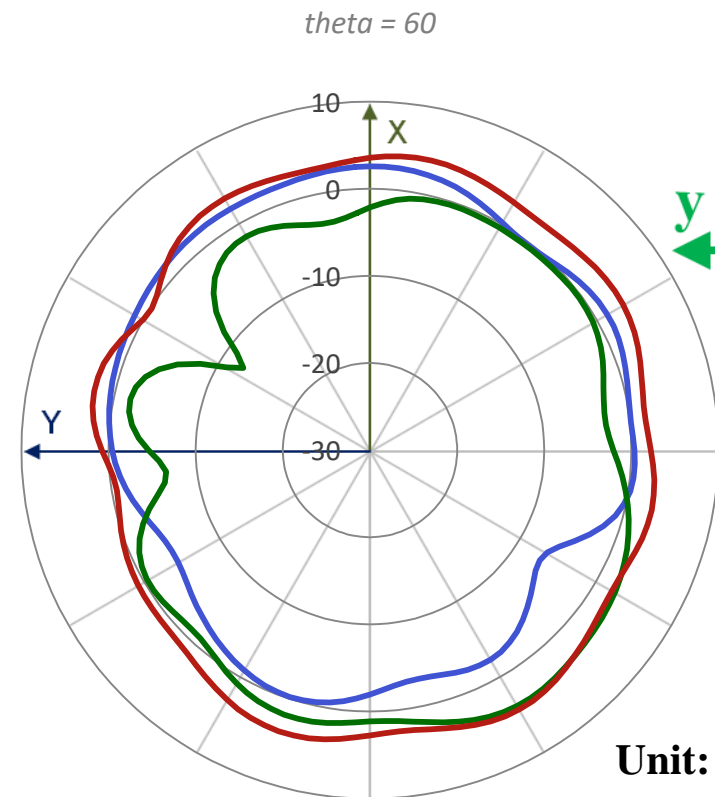
Realized Gain Pattern Scanning @2400MHz for Gtotal



— SC1 — SC2 — Composite



— SC1 — SC2 — Composite

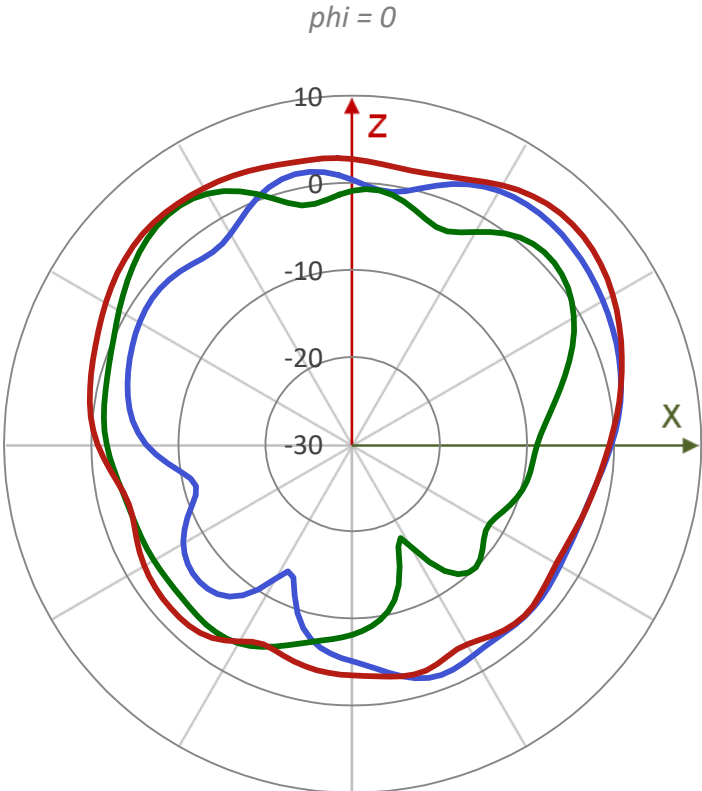


— SC1 — SC2 — Composite

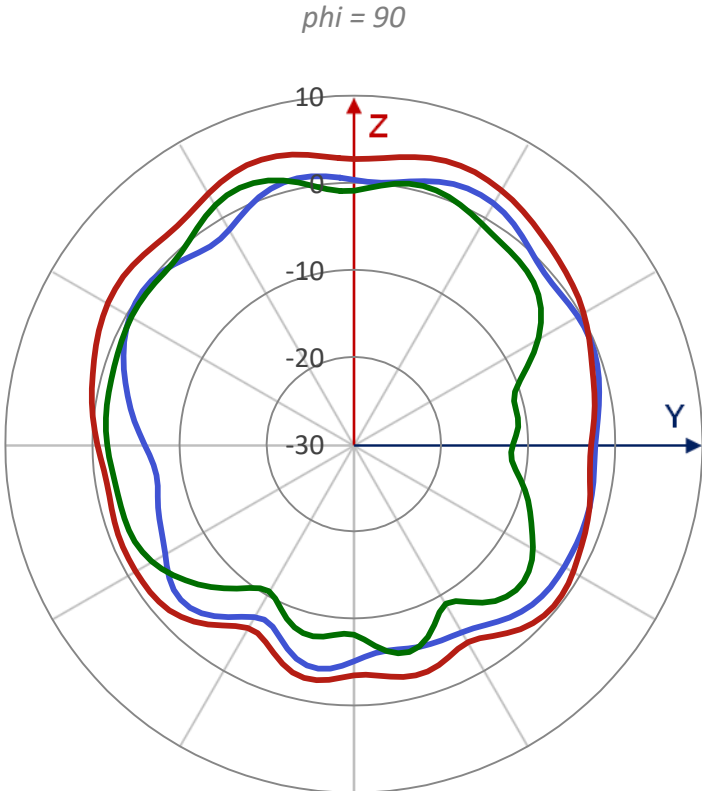
Unit: dBi



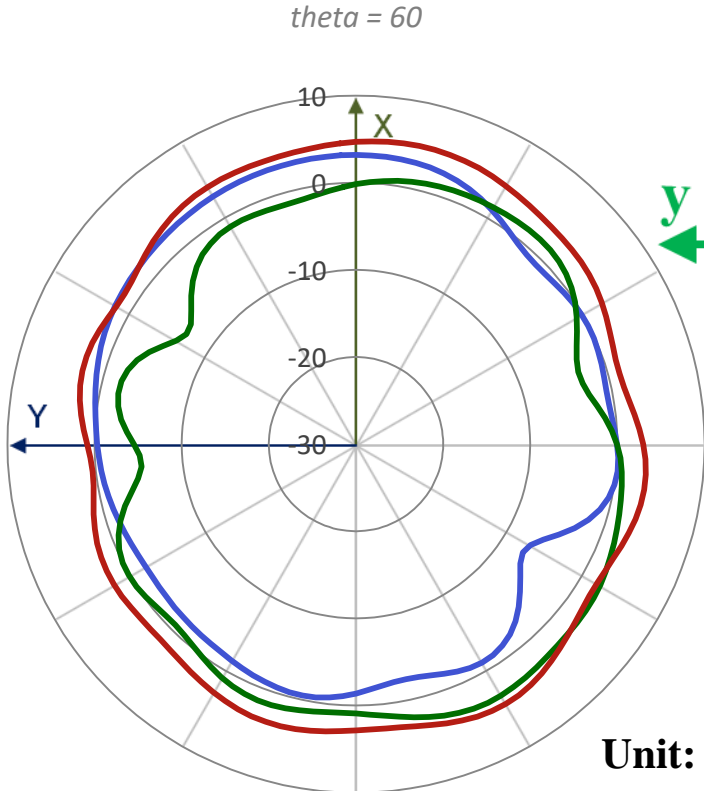
Realized Gain Pattern Scanning @2440MHz for Gtotal



— SC1 — SC2 — Composite



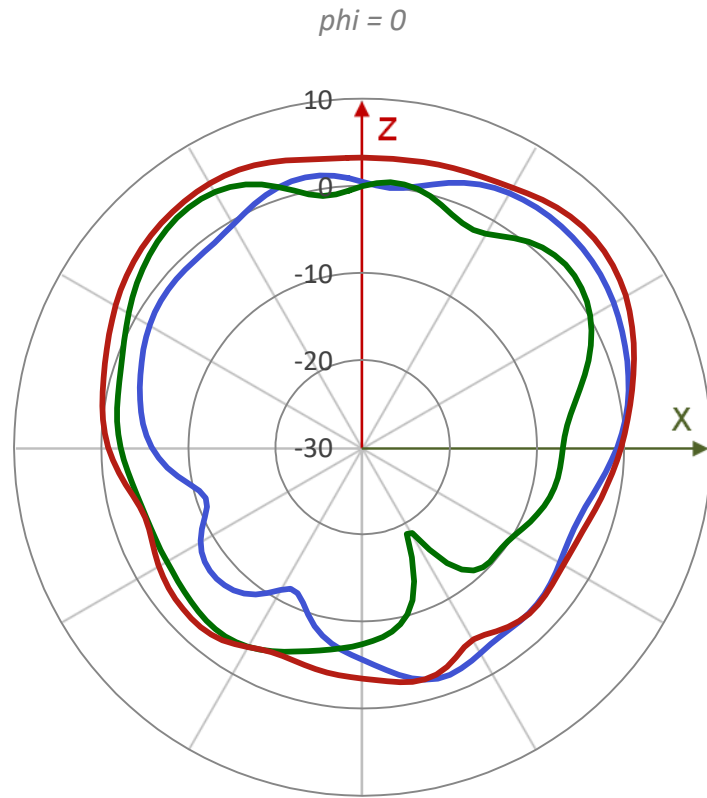
— SC1 — SC2 — Composite



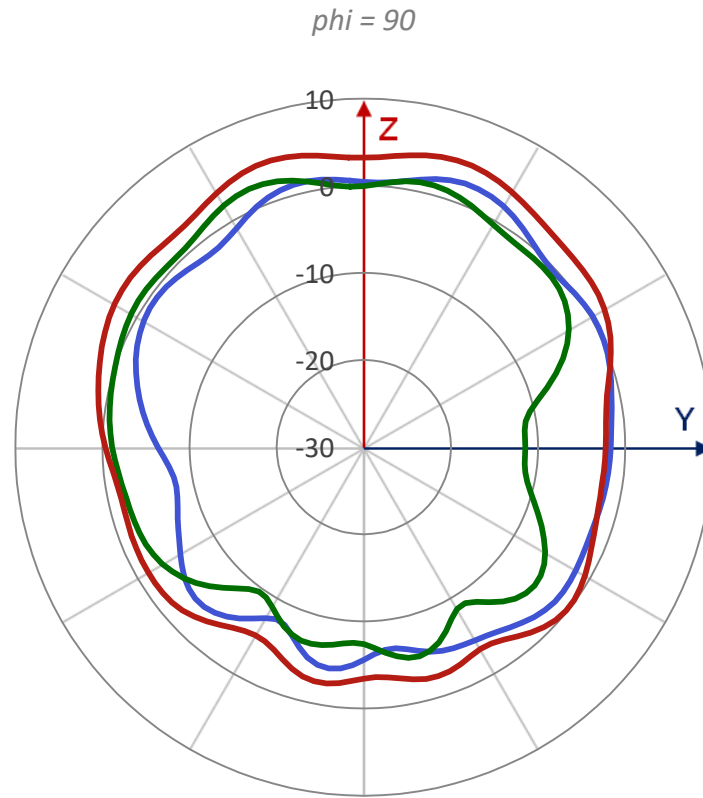
— SC1 — SC2 — Composite



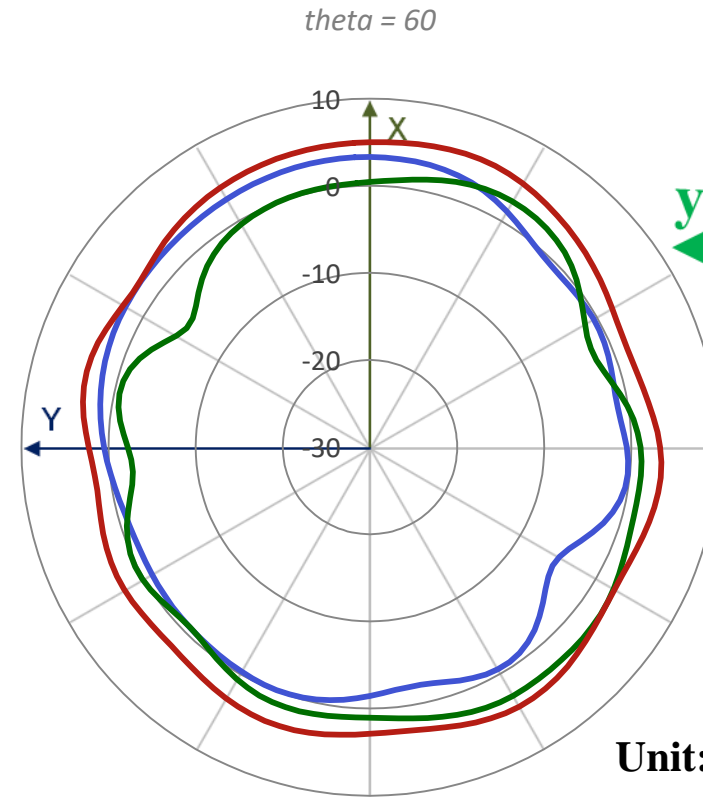
Realized Gain Pattern Scanning @2480MHz for Gtotal



— SC1 — SC2 — Composite



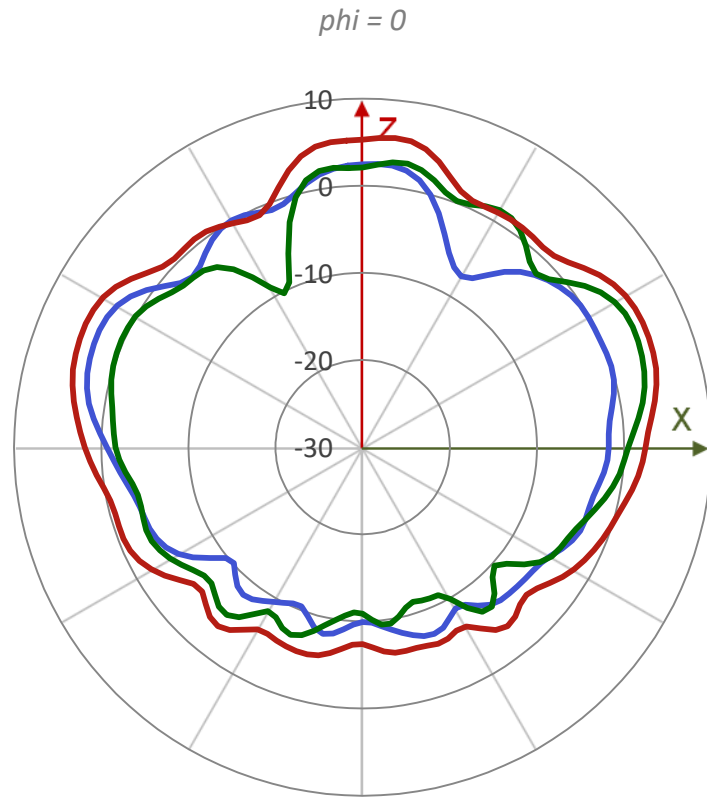
— SC1 — SC2 — Composite



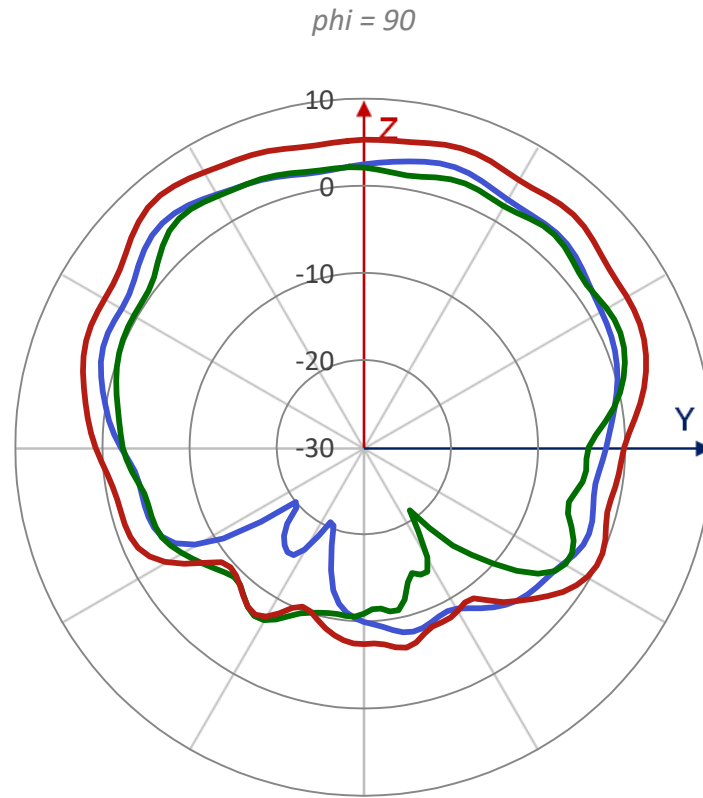
— SC1 — SC2 — Composite



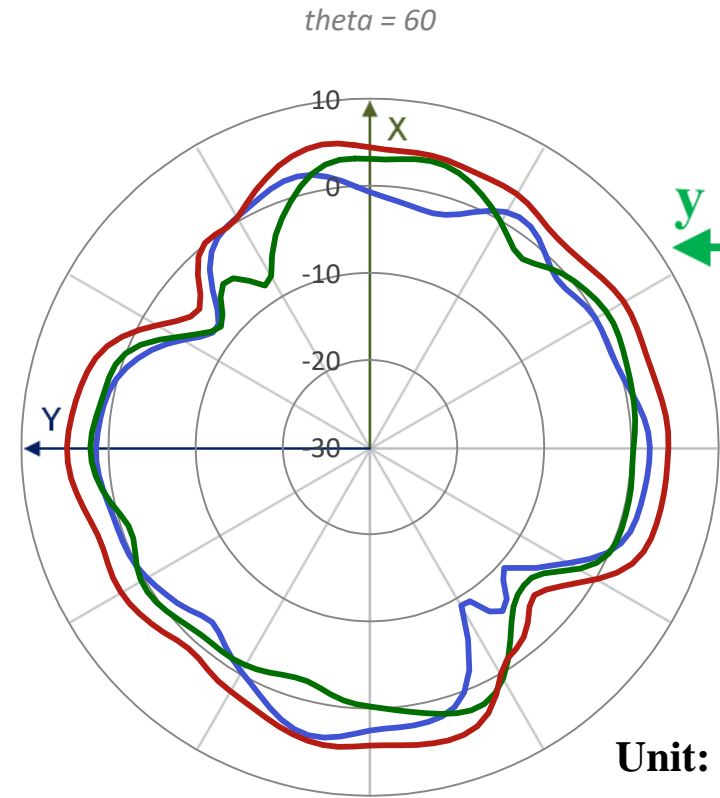
Realized Gain Pattern Scanning @5150MHz for Gtotal



— SC1 — SC2 — Composite



— SC1 — SC2 — Composite

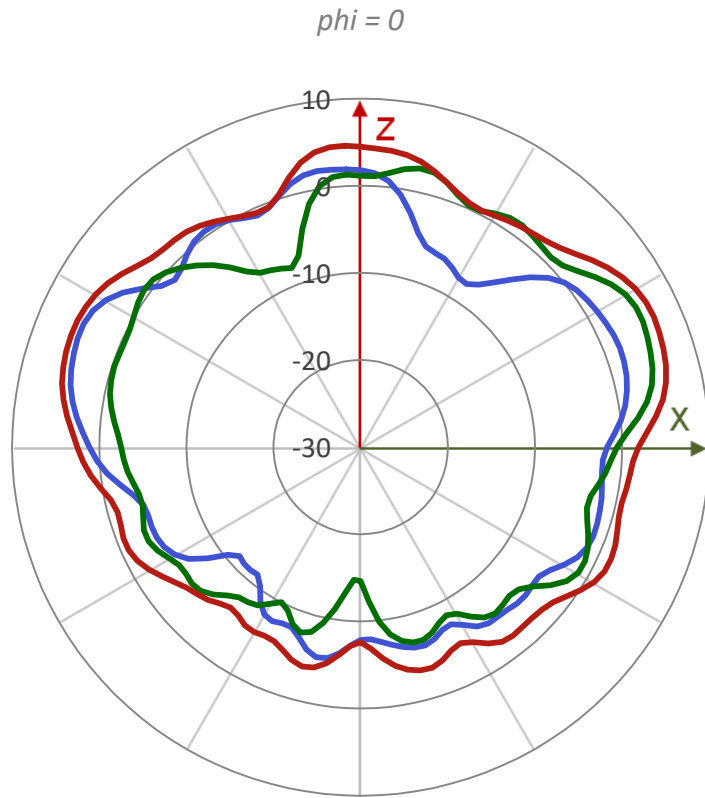


— SC1 — SC2 — Composite

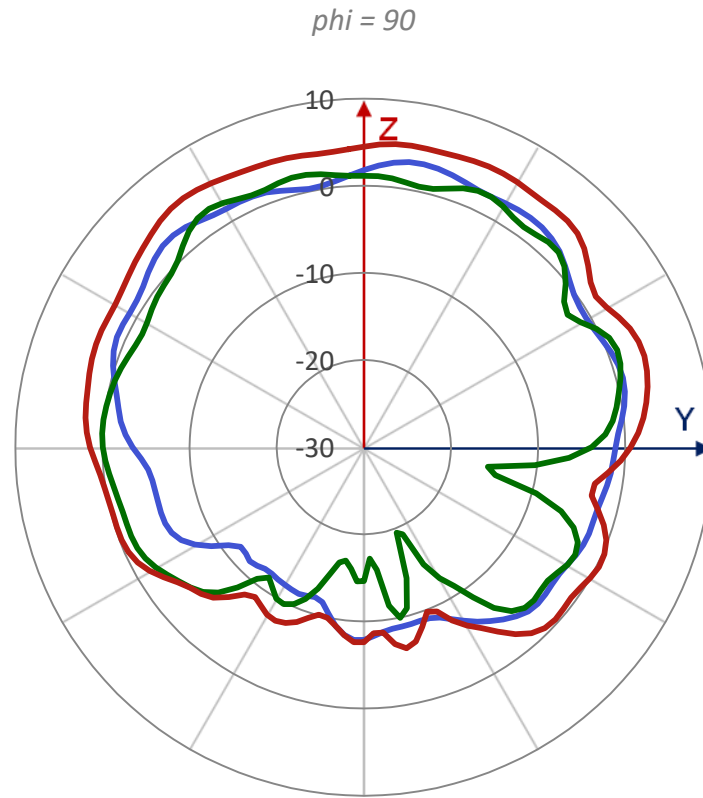
Unit: dBi



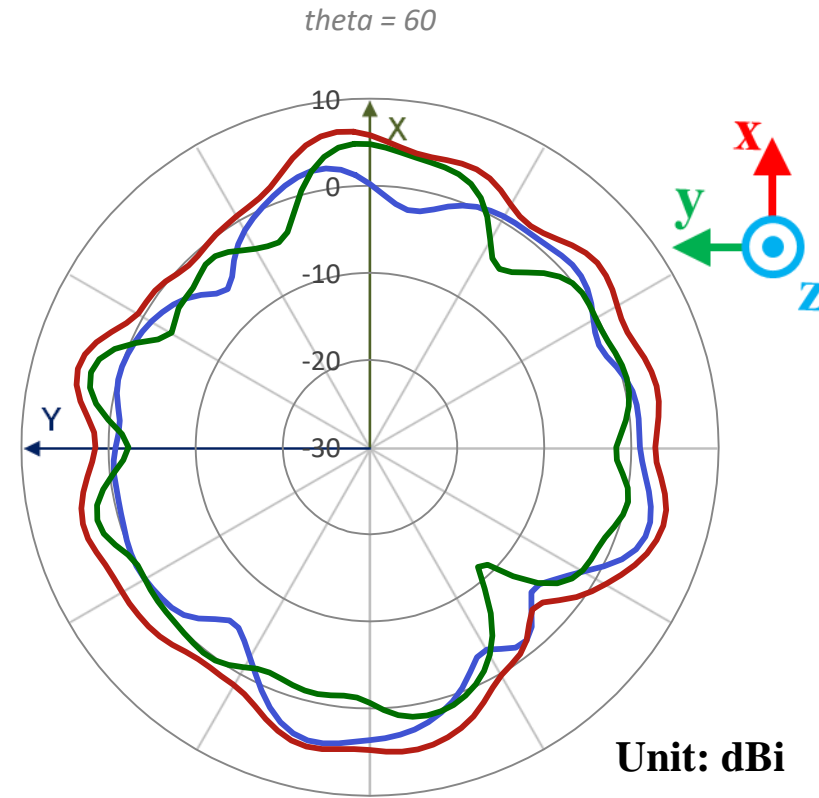
Realized Gain Pattern Scanning @5450MHz for Gtotal



— SC1 — SC2 — Composite



— SC1 — SC2 — Composite

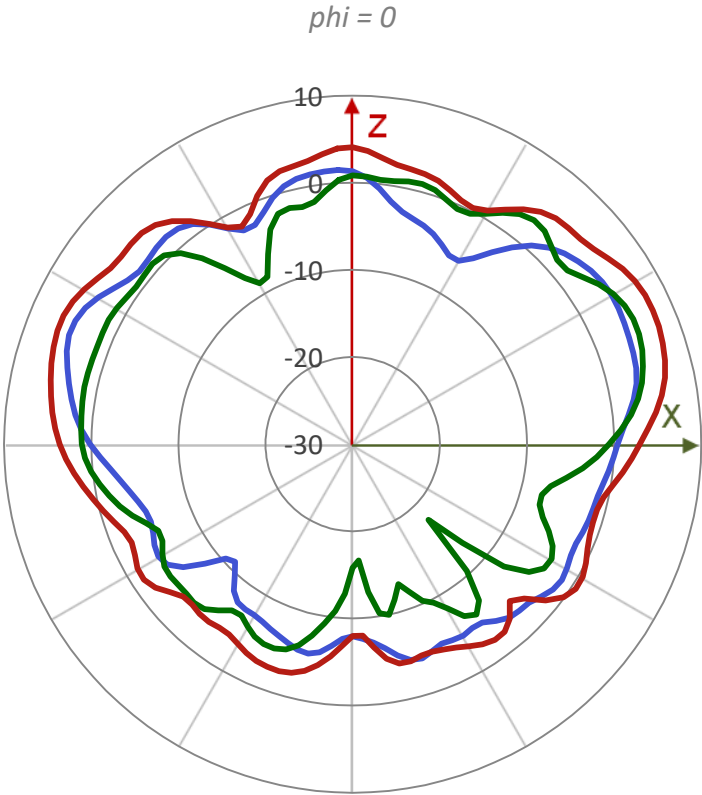


— SC1 — SC2 — Composite

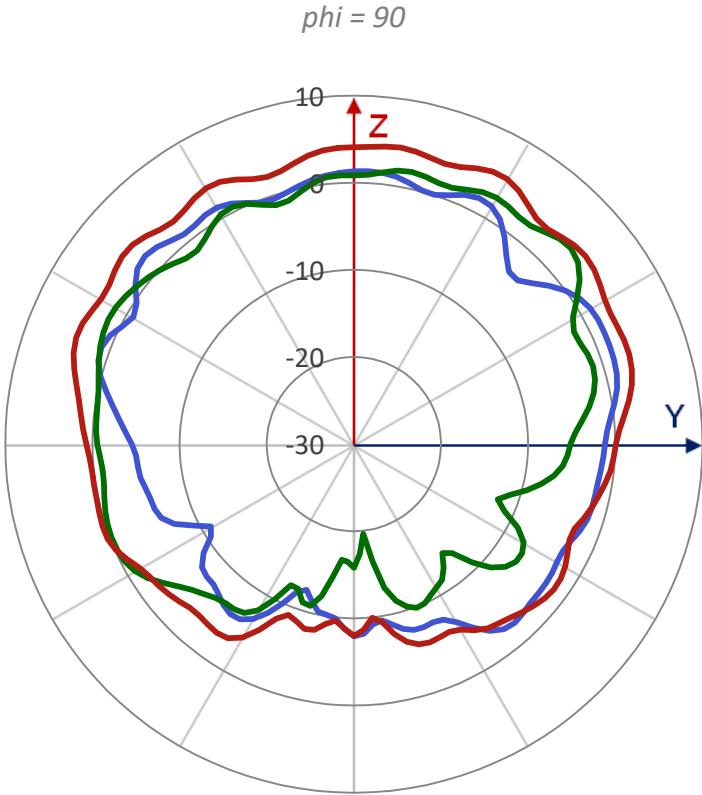
Unit: dBi



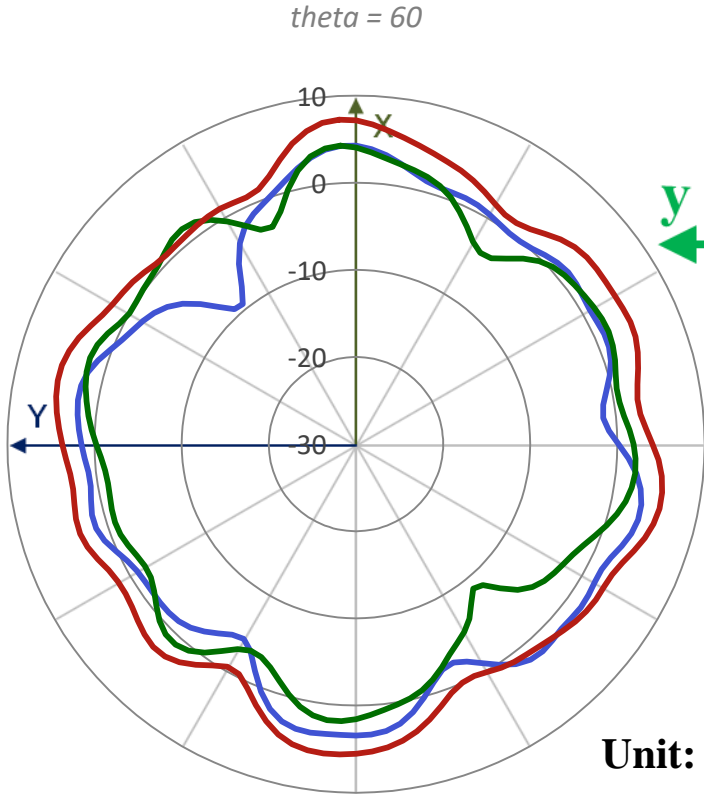
Realized Gain Pattern Scanning @5850MHz for Gtotal



— SC1 — SC2 — Composite



— SC1 — SC2 — Composite

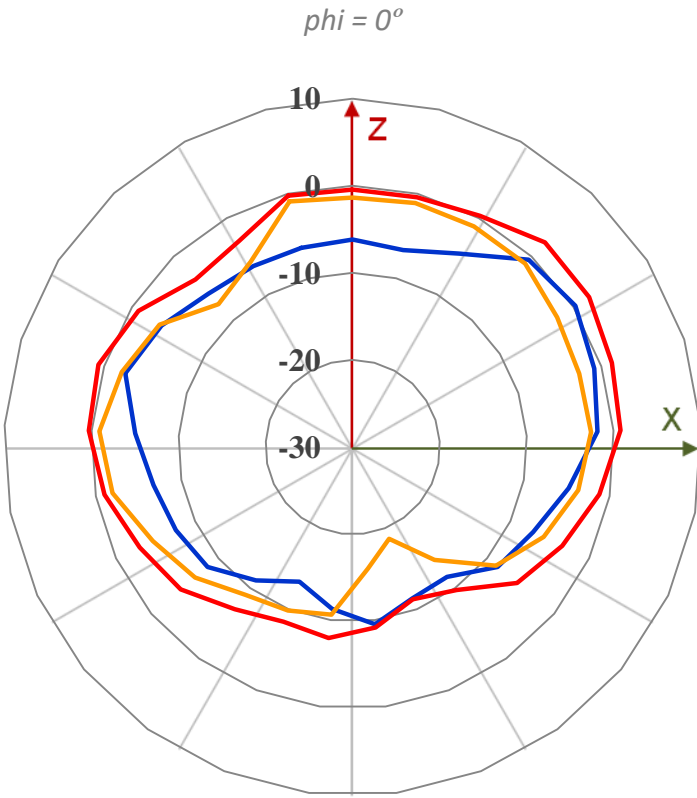


— SC1 — SC2 — Composite

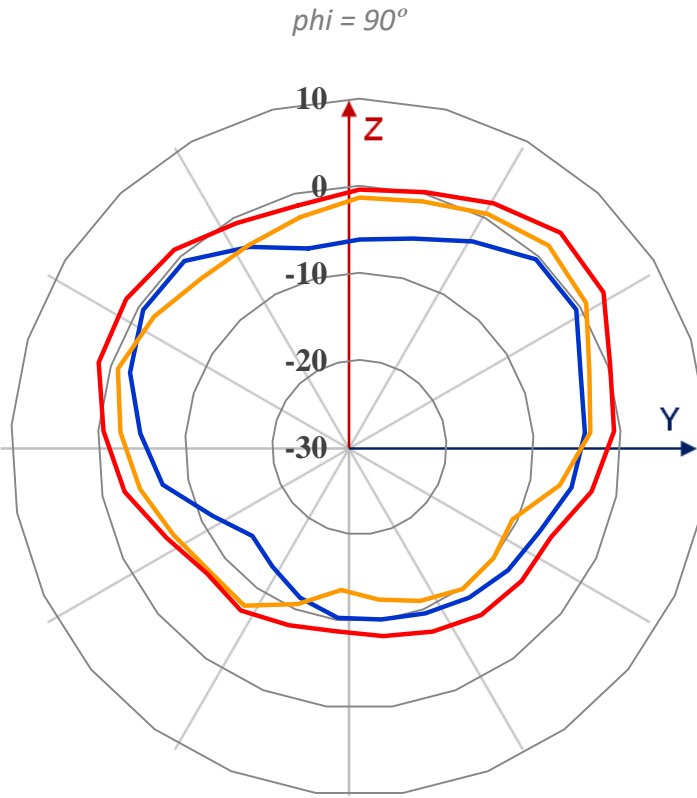
Unit: dBi



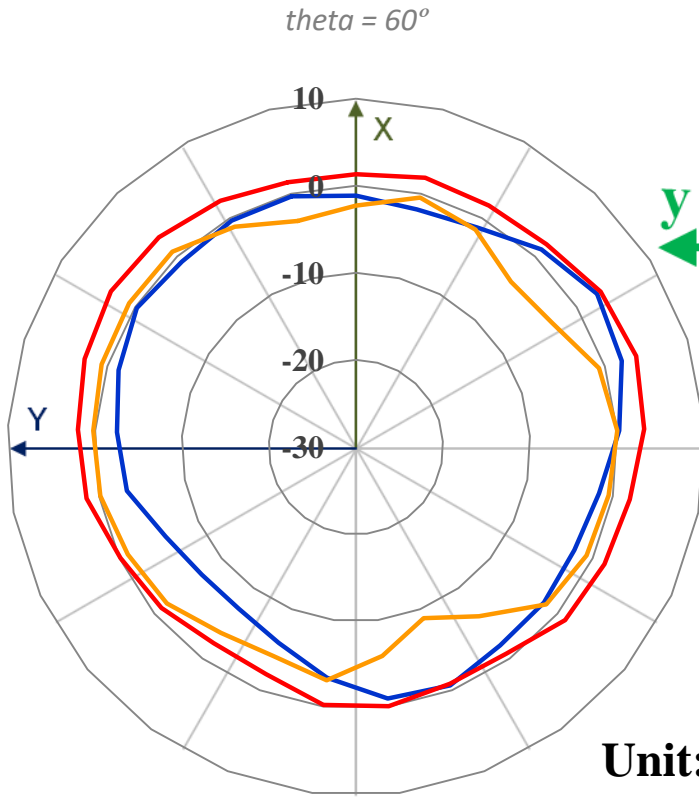
Realized Gain Pattern Scanning @5925MHz for G_{total}



— SC1 — SC2 — Composite



— SC1 — SC2 — Composite

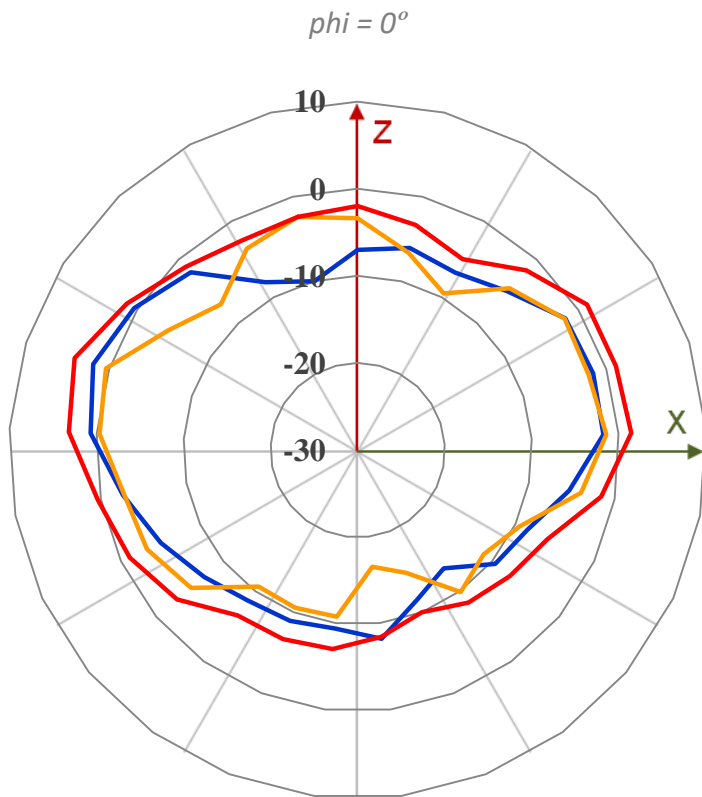


— SC1 — SC2 — Composite

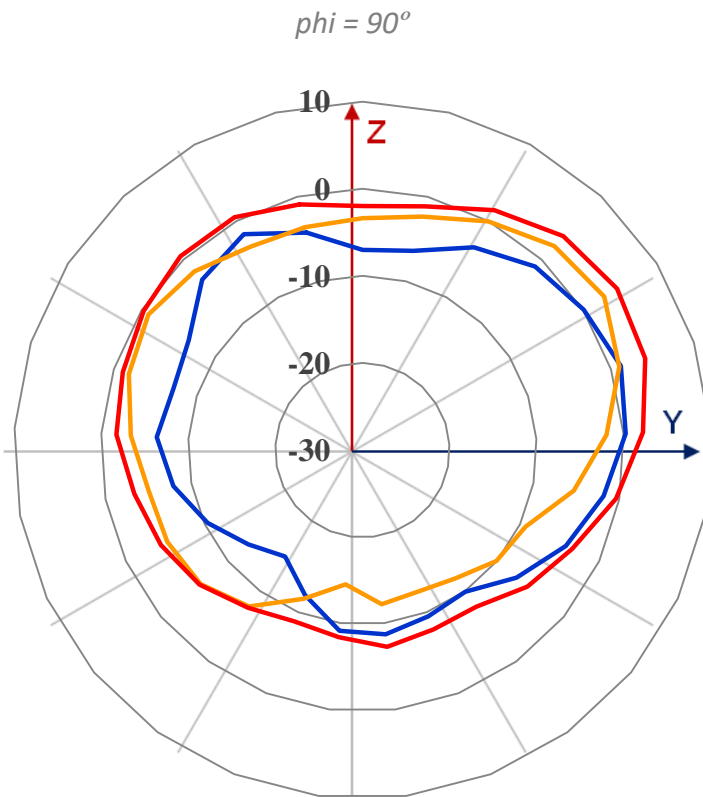
Unit: dBi



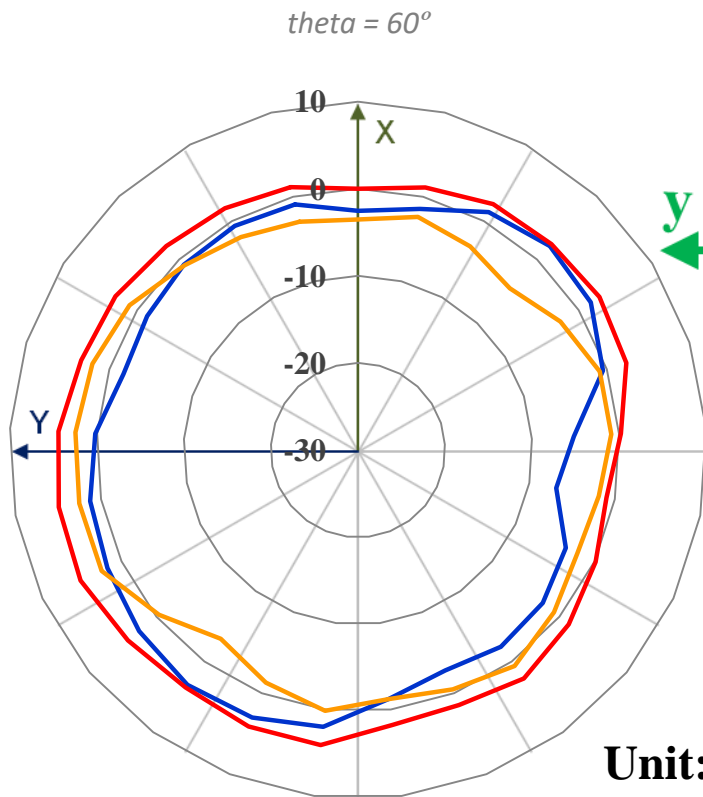
Realized Gain Pattern Scanning @6565MHz for G_{total}



— SC1 — SC2 — Composite



— SC1 — SC2 — Composite

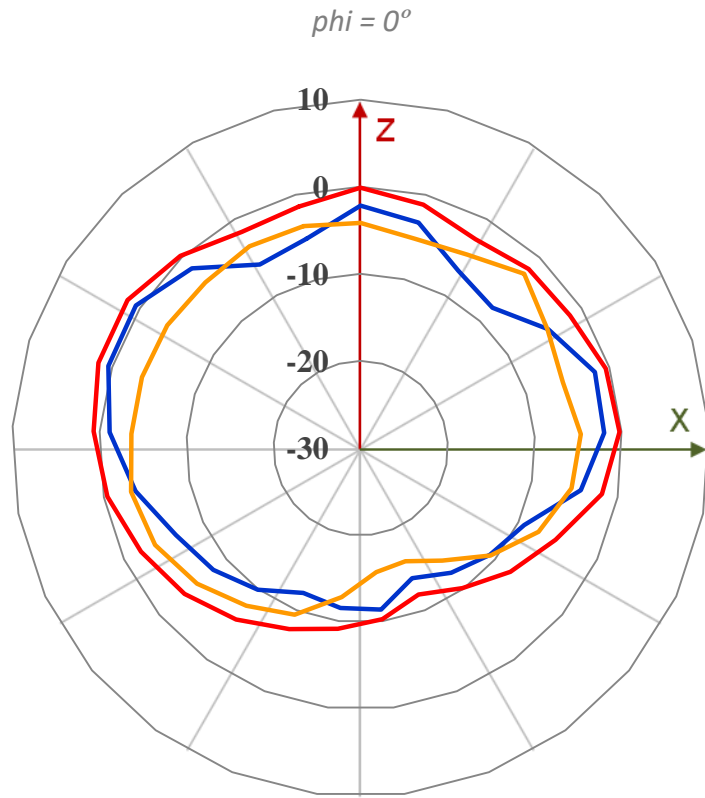


— SC1 — SC2 — Composite

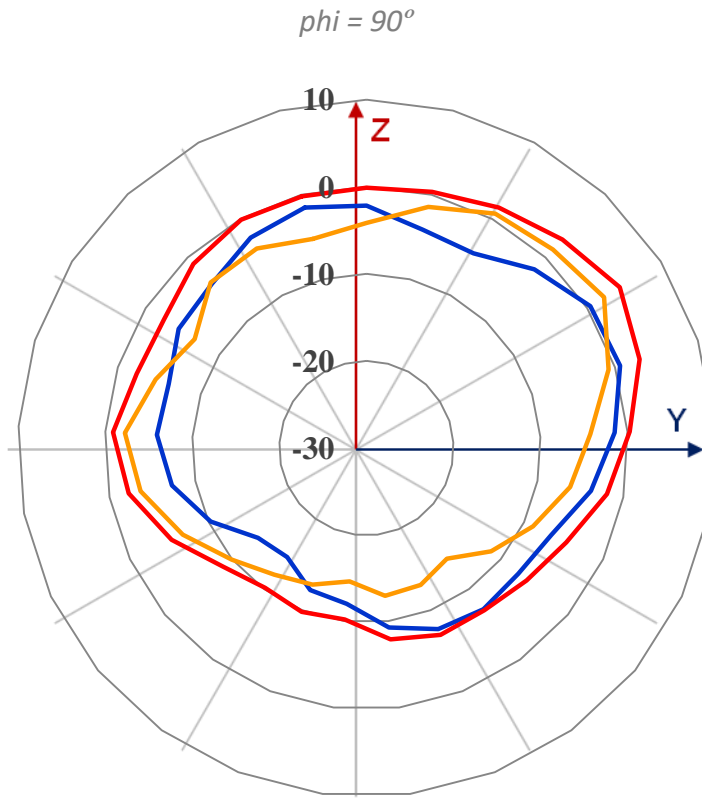
Unit: dBi



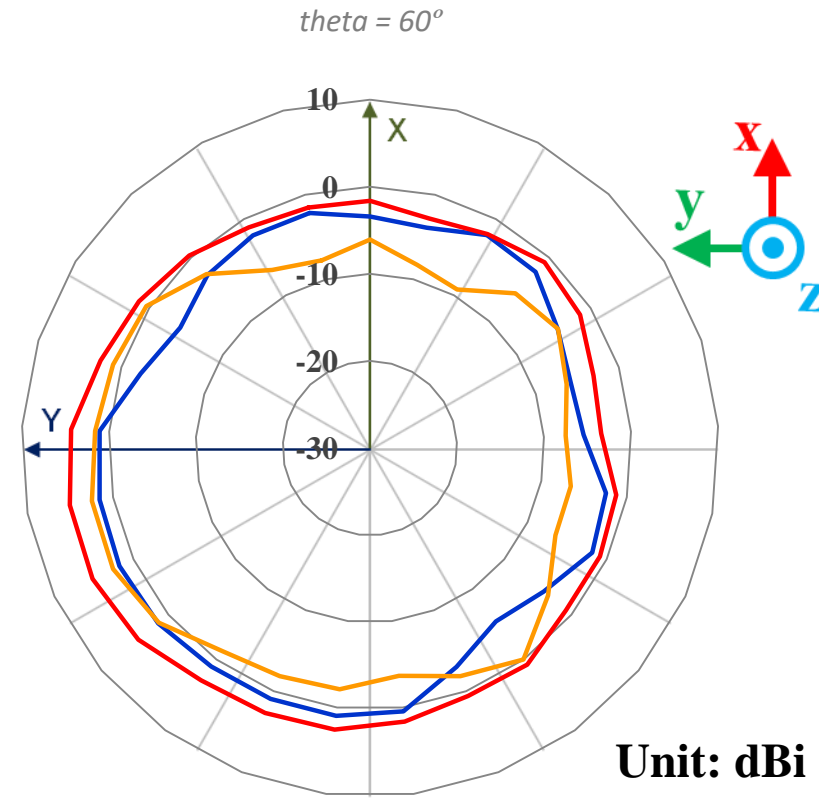
Realized Gain Pattern Scanning @7125MHz for G_{total}



— SC1 — SC2 — Composite



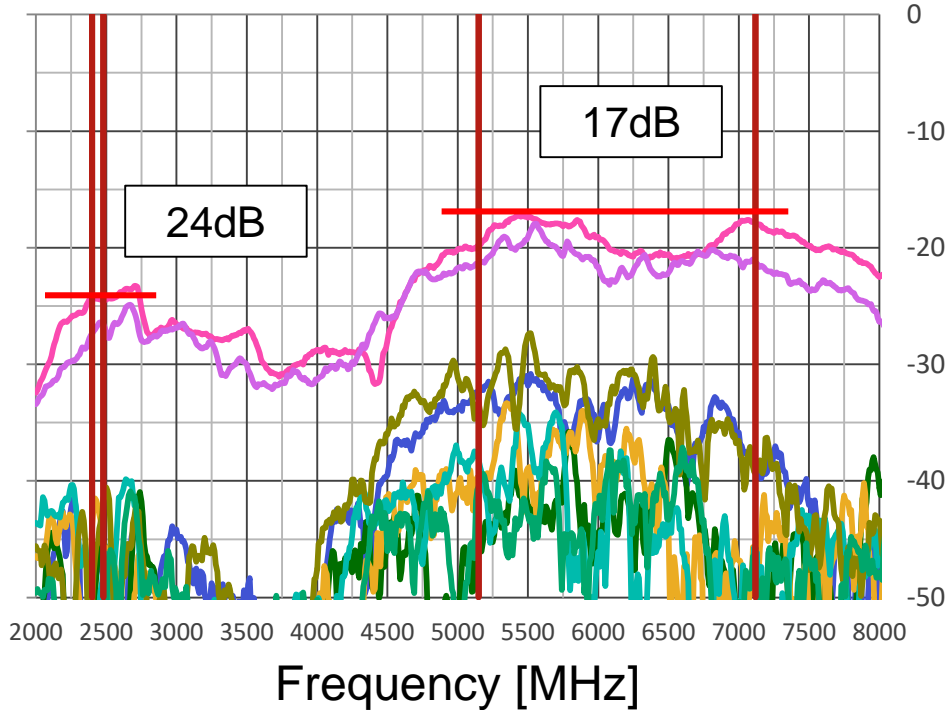
— SC1 — SC2 — Composite



— SC1 — SC2 — Composite



Isolation Scanning to Single 6G



- SC1_6G1 — SC1_6G2 — SC1_6G3
- SC1_6G4 — SC2_6G1 — SC2_6G2
- SC2_6G3 — SC2_6G4 —

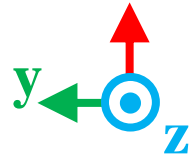
| 2.4GHz | Max | Mean | Min | 5_6GHz | Max | Mean | Min |
|---------|-------|-------|-------|---------|-------|-------|-------|
| SC1_6G1 | -45.0 | -48.1 | -54.9 | SC1_6G1 | -30.8 | -34.1 | -40.4 |
| SC1_6G2 | -45.1 | -47.6 | -51.8 | SC1_6G2 | -35.8 | -43.6 | -66.5 |
| SC1_6G3 | -41.5 | -43.1 | -45.2 | SC1_6G3 | -33.3 | -41.9 | -68.4 |
| SC1_6G4 | -24.3 | -24.4 | -24.5 | SC1_6G4 | -17.2 | -19.1 | -21.0 |
| SC2_6G1 | -47.1 | -53.9 | -61.9 | SC2_6G1 | -34.1 | -44.8 | -65.4 |
| SC2_6G2 | -26.4 | -26.8 | -27.4 | SC2_6G2 | -17.9 | -20.8 | -23.2 |
| SC2_6G3 | -41.5 | -45.4 | -50.8 | SC2_6G3 | -27.3 | -33.4 | -41.6 |
| SC2_6G4 | -51.7 | -53.1 | -55.6 | SC2_6G4 | -37.1 | -44.3 | -70.4 |
| Summary | -24.3 | -42.8 | -61.9 | Summary | -17.2 | -35.3 | -70.4 |



BLE Array – Directional Beam [P2A Sample]

■ Efficiency

- ~22.2% on 2.4GHz [Beam1~Beam8]
- ~34.4% on 2.4GHz [Beam9]



■ Peak Gain

- 4.7dBi on 2.4GHz [Beam1~Beam8]
- 4.5dBi on 2.4GHz [Beam9]

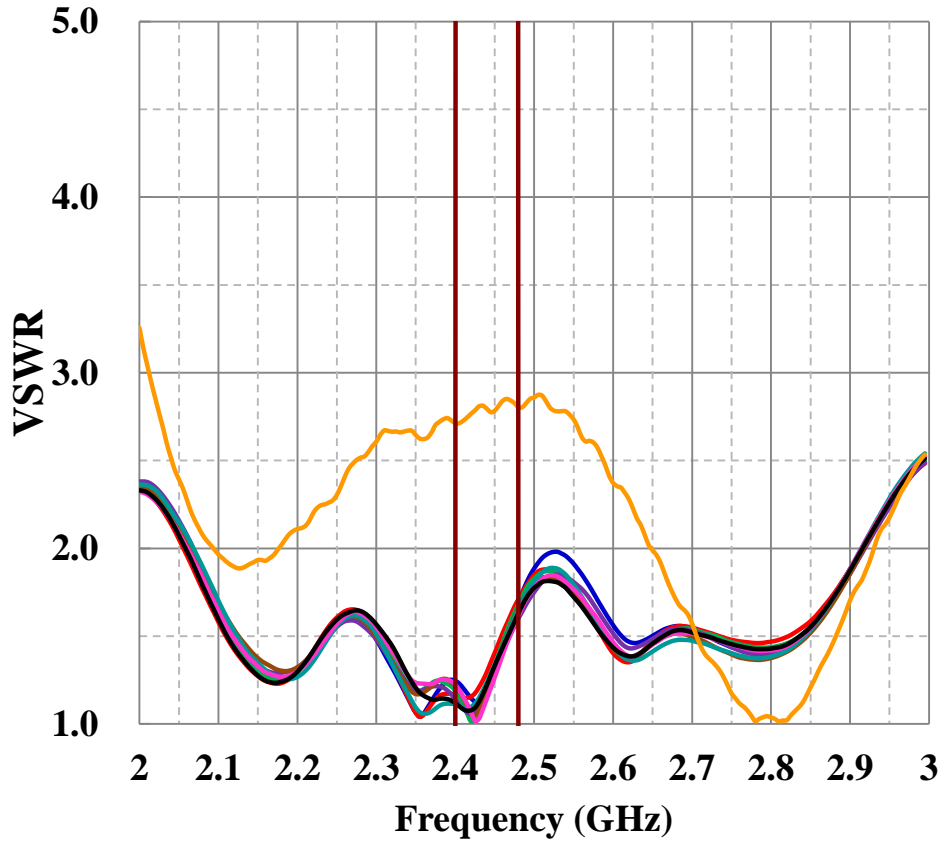
■ Beam Width

- ~40.8° on 2.4GHz [Beam1~Beam8]

X



VSWR Directional Beam – P2A Sample

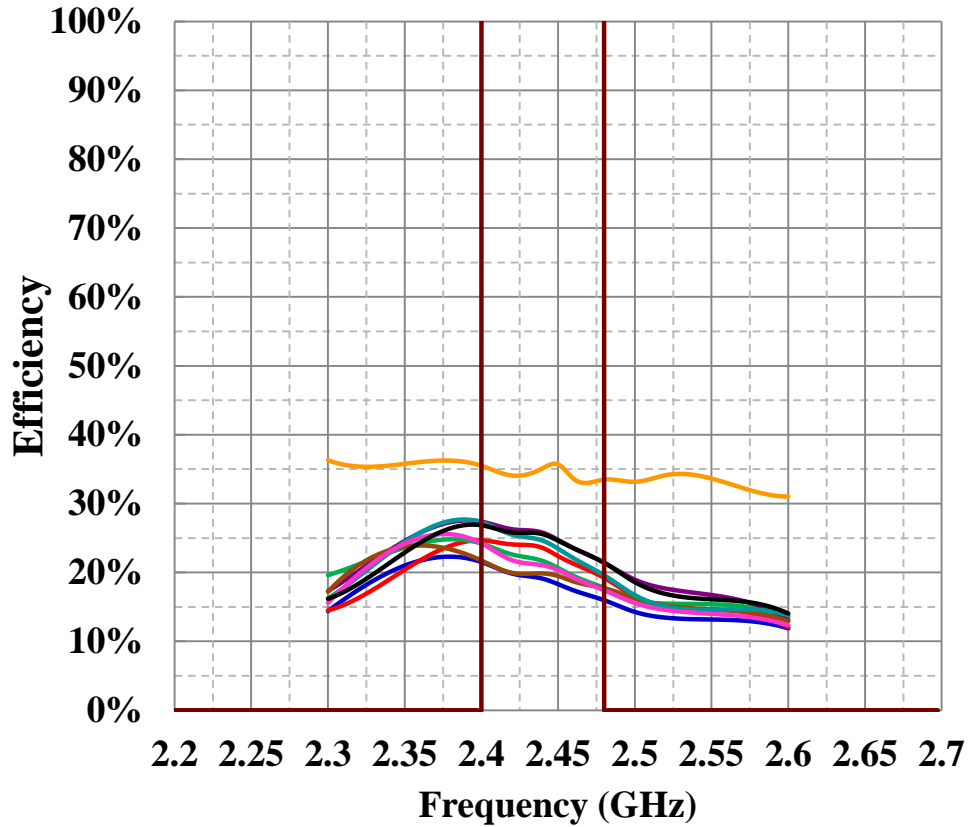


— Beam1 — Beam2 — Beam3 — Beam4 — Beam5
— Beam6 — Beam7 — Beam8 — Beam9 —

| 2.4GHz | Max | Mean | Min |
|--------|------|------|------|
| Beam 1 | 1.69 | 1.32 | 1.13 |
| Beam 2 | 1.71 | 1.35 | 1.15 |
| Beam 3 | 1.68 | 1.29 | 1.01 |
| Beam 4 | 1.60 | 1.26 | 1.06 |
| Beam 5 | 1.66 | 1.29 | 1.05 |
| Beam 6 | 1.65 | 1.29 | 1.09 |
| Beam 7 | 1.62 | 1.26 | 1.02 |
| Beam 8 | 1.63 | 1.28 | 1.08 |
| Beam 9 | 2.85 | 2.79 | 2.71 |



Efficiency Directional Beam – P2A Sample

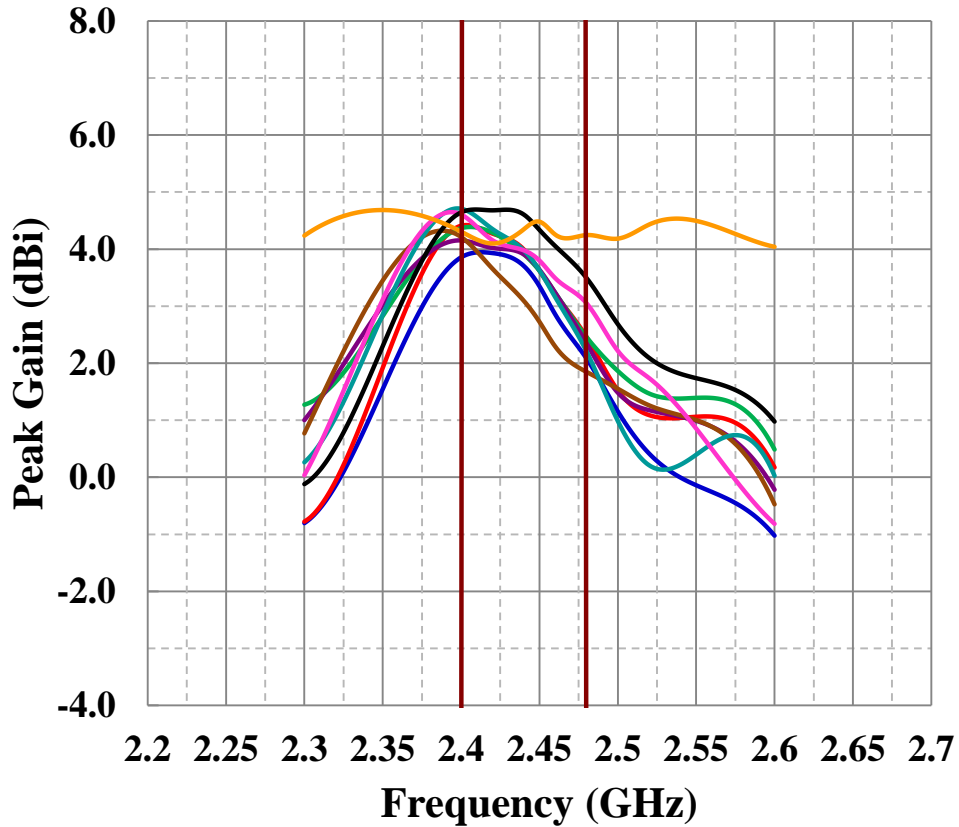


— Beam1 — Beam2 — Beam3 — Beam4 — Beam5
— Beam6 — Beam7 — Beam8 — Beam9 —

| 2.4GHz | Max | Mean | Min |
|--------|-------|-------|-------|
| Beam 1 | 21.5% | 18.9% | 16.2% |
| Beam 2 | 24.7% | 22.8% | 19.5% |
| Beam 3 | 24.2% | 21.3% | 18.0% |
| Beam 4 | 27.4% | 25.1% | 21.7% |
| Beam 5 | 21.7% | 19.6% | 17.8% |
| Beam 6 | 27.3% | 24.0% | 19.9% |
| Beam 7 | 24.2% | 20.8% | 17.7% |
| Beam 8 | 26.9% | 24.9% | 21.7% |
| Beam 9 | 35.8% | 34.4% | 33.0% |



Peak Gain Directional Beam – P2A Sample

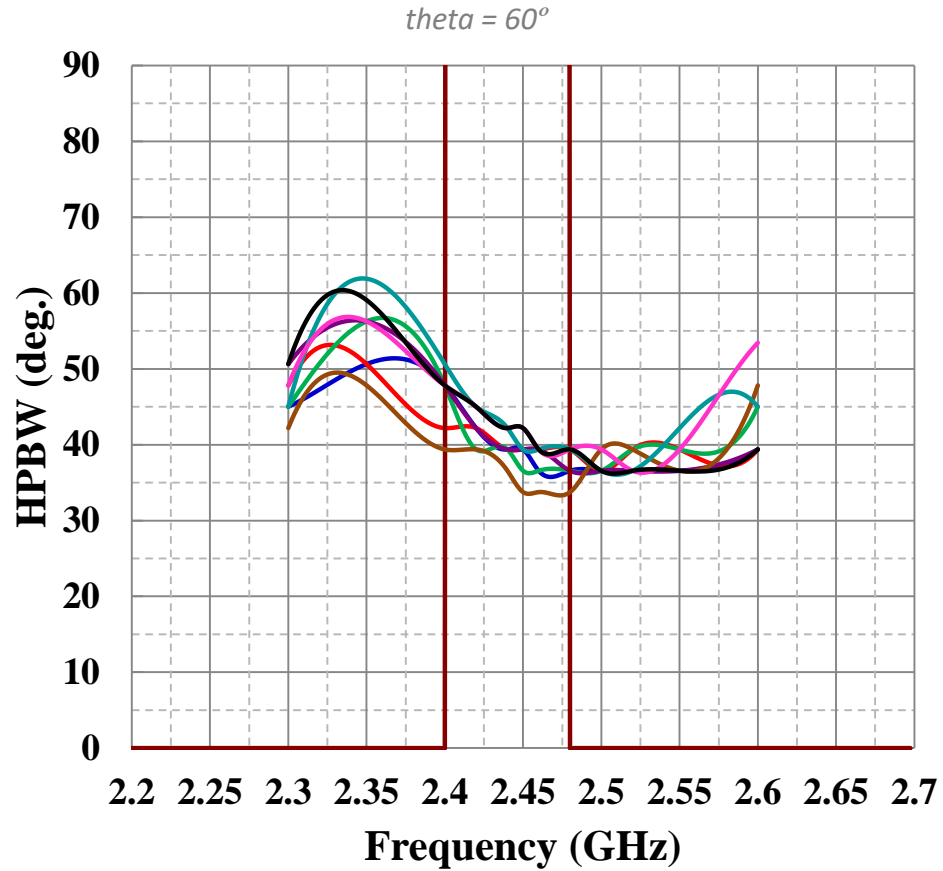


| 2.4GHz | Max | Mean | Min |
|--------|---------|---------|---------|
| Beam 1 | 3.9 dBi | 3.4 dBi | 2.2 dBi |
| Beam 2 | 4.4 dBi | 3.8 dBi | 2.6 dBi |
| Beam 3 | 4.4 dBi | 3.8 dBi | 2.5 dBi |
| Beam 4 | 4.2 dBi | 3.7 dBi | 2.5 dBi |
| Beam 5 | 4.2 dBi | 3.1 dBi | 1.9 dBi |
| Beam 6 | 4.7 dBi | 3.8 dBi | 2.3 dBi |
| Beam 7 | 4.6 dBi | 3.9 dBi | 3.1 dBi |
| Beam 8 | 4.7 dBi | 4.4 dBi | 3.6 dBi |
| Beam 9 | 4.5 dBi | 4.2 dBi | 4.1 dBi |

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



3dB Beam Width Directional Beam – P2A Sample

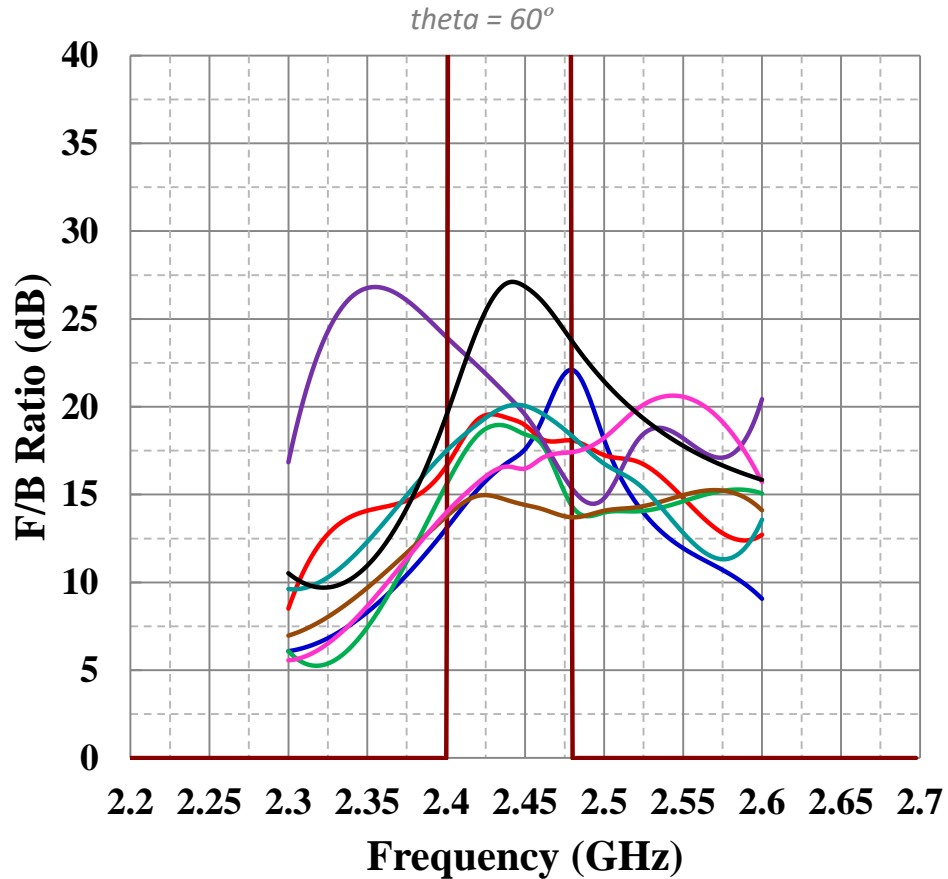


— Beam1 — Beam2 — Beam3 — Beam4 — Beam5
— Beam6 — Beam7 — Beam8 — Beam8

| 2.4GHz | Max | Mean | Min |
|--------|-----|------|-----|
| Beam 1 | 48° | 40° | 36° |
| Beam 2 | 42° | 41° | 39° |
| Beam 3 | 48° | 39° | 36° |
| Beam 4 | 48° | 41° | 37° |
| Beam 5 | 39° | 36° | 33° |
| Beam 6 | 51° | 43° | 39° |
| Beam 7 | 48° | 43° | 39° |
| Beam 8 | 48° | 43° | 39° |



Front to Back Ratio Directional Beam – P2A Sample

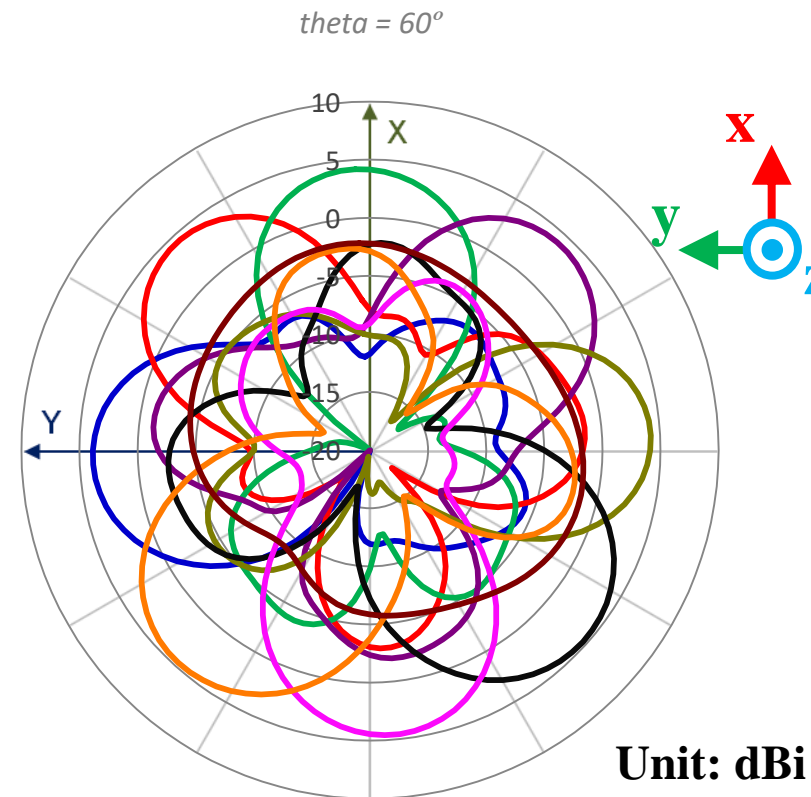
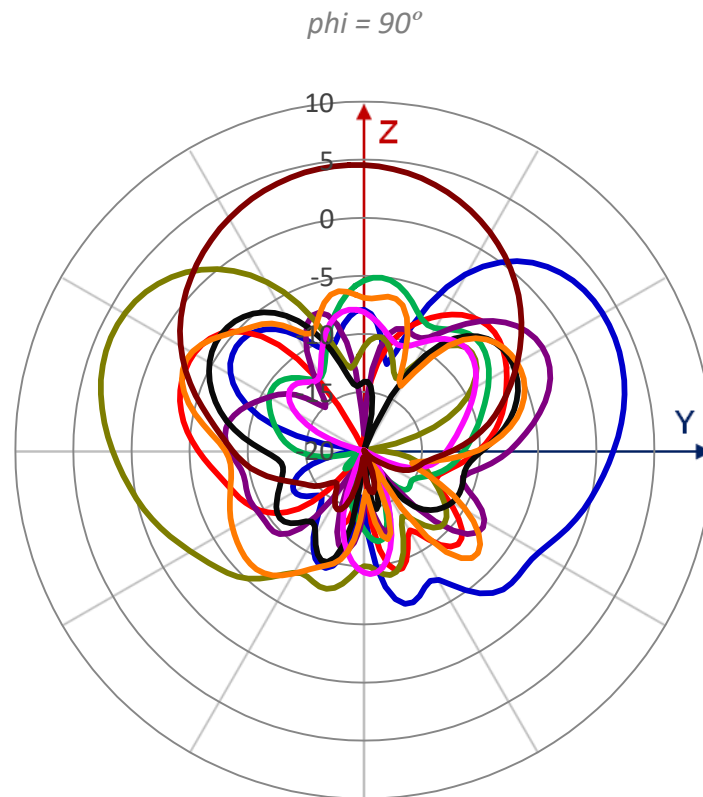
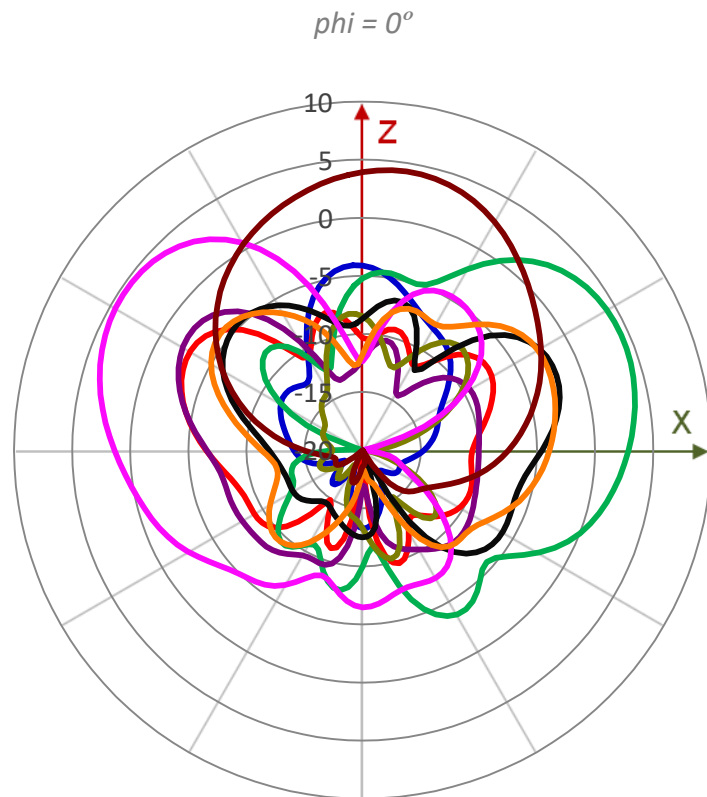


— Beam1
 — Beam2
 — Beam3
 — Beam4
 — Beam5
 — Beam6
 — Beam7
 — Beam8

| 2.4GHz | Max | Mean | Min |
|--------|--------|--------|--------|
| Beam 1 | 22.1dB | 17.1dB | 13.1dB |
| Beam 2 | 19.6dB | 18.6dB | 16.6dB |
| Beam 3 | 19.0dB | 17.6dB | 14.7dB |
| Beam 4 | 24.0dB | 20.3dB | 15.6dB |
| Beam 5 | 15.0dB | 14.4dB | 13.7dB |
| Beam 6 | 20.1dB | 19.2dB | 17.5dB |
| Beam 7 | 17.4dB | 16.2dB | 14.0dB |
| Beam 8 | 27.1dB | 24.9dB | 19.5dB |



Realized Gain Pattern Directional Beam – P2A Sample @2400MHz for G_{total}



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

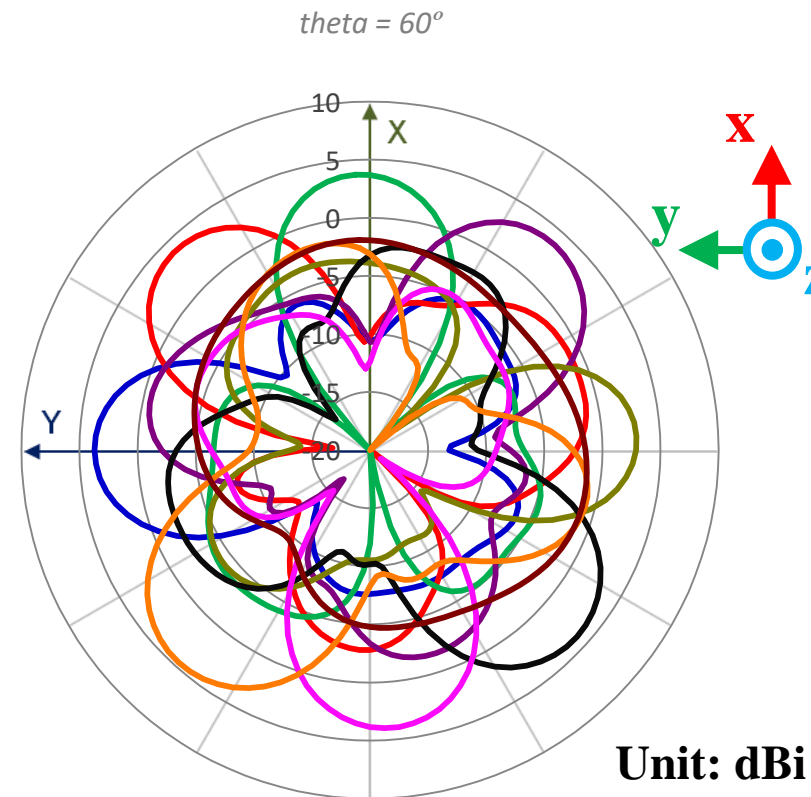
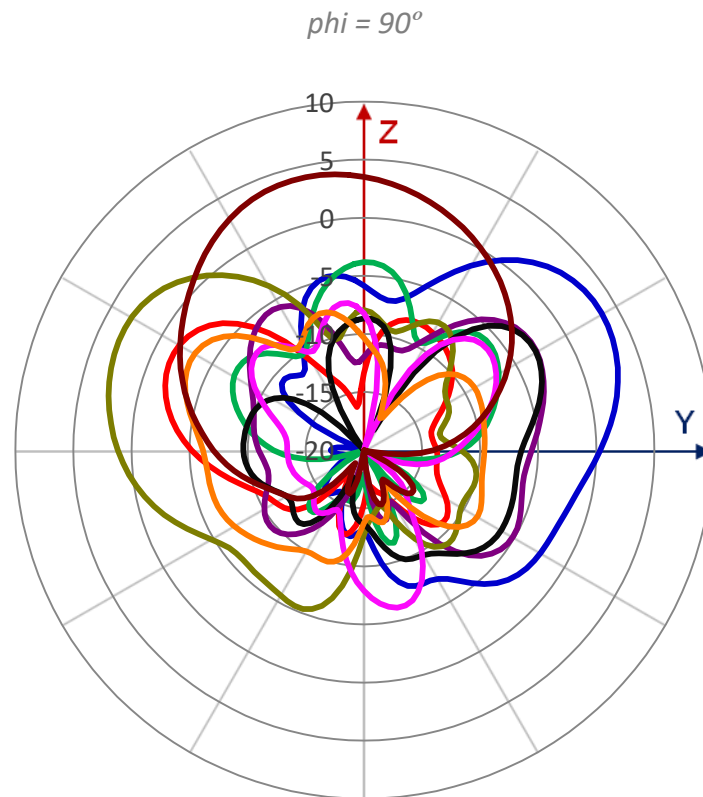
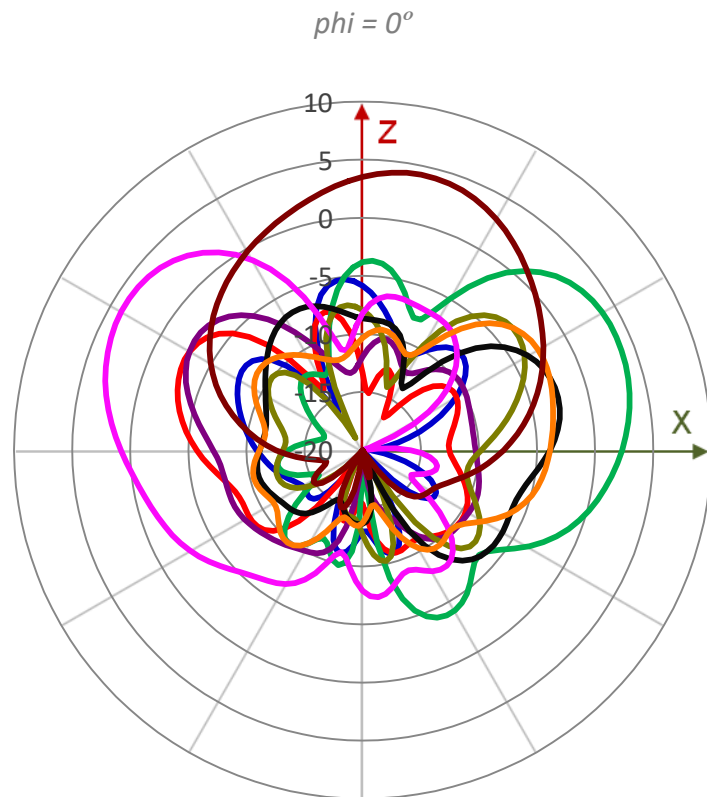
- Beam1 — Beam2 — Beam3
- Beam4 — Beam5 — Beam6
- Beam7 — Beam8 — Beam9

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

Unit: dBi



Realized Gain Pattern Directional Beam – P2A Sample @2440MHz for G_{total}



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

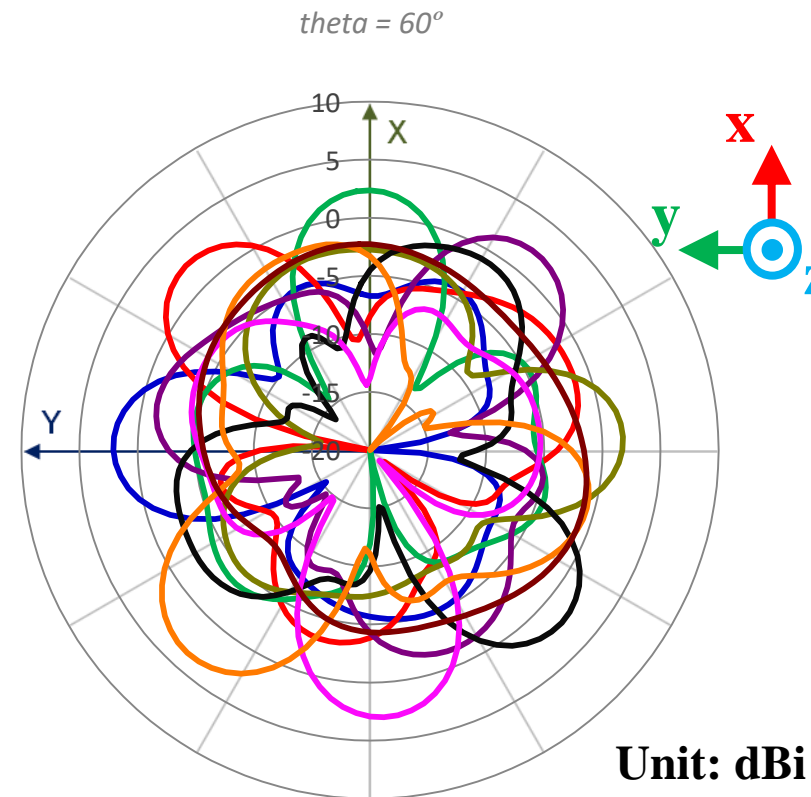
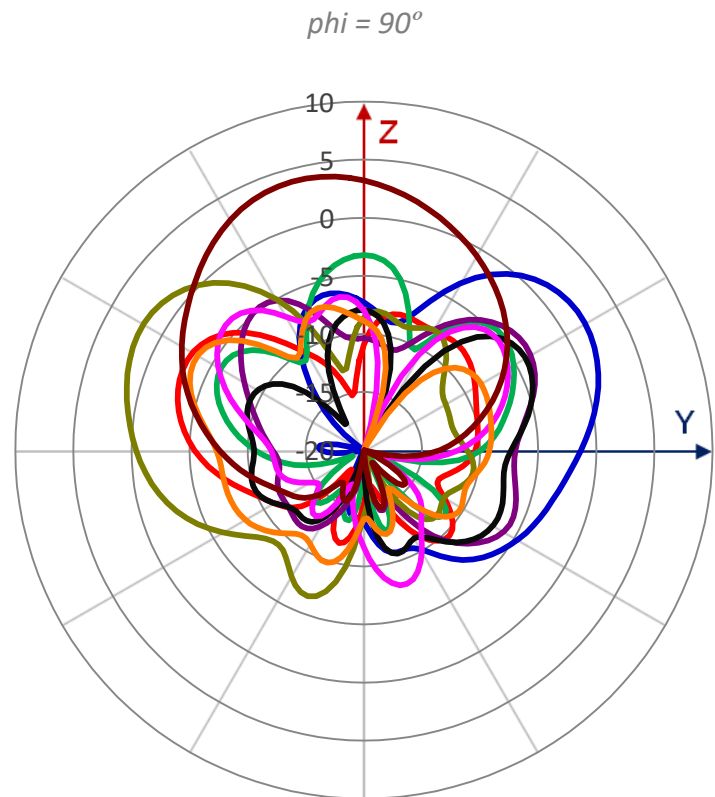
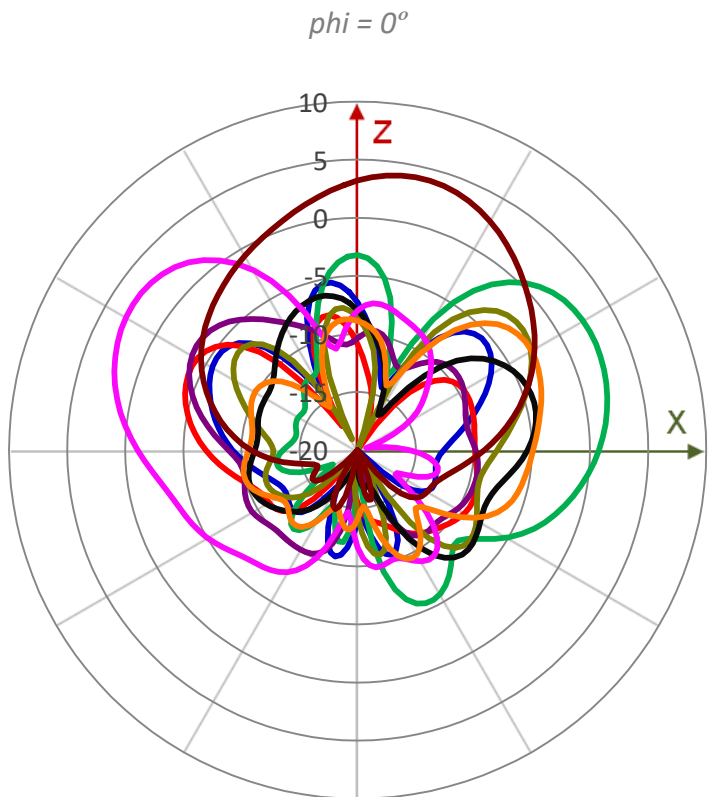
- Beam1 — Beam2 — Beam3
- Beam4 — Beam5 — Beam6
- Beam7 — Beam8 — Beam9

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

Unit: dBi



Realized Gain Pattern Directional Beam – P2A Sample @2480MHz for G_{total}



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

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

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

Unit: dBi



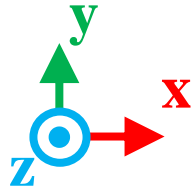
BLE Array – Omni Beam [P2A Sample]

- **Efficiency**

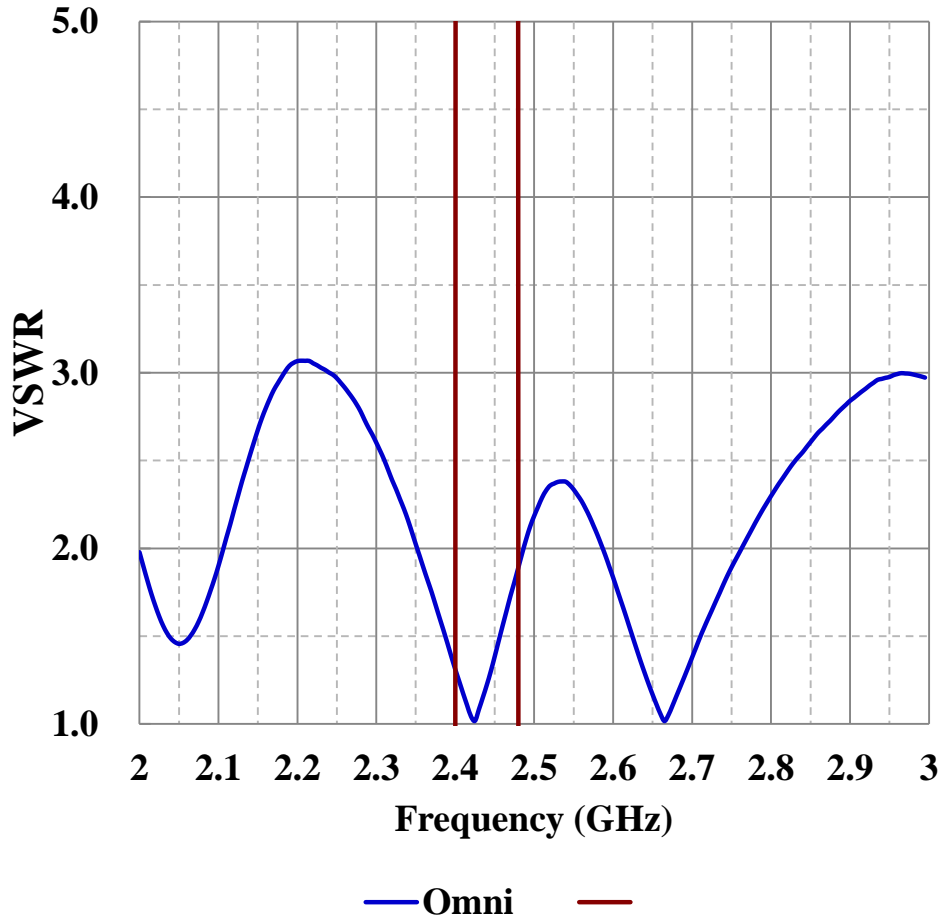
- ~28.4% on 2.4GHz

- **Peak Gain**

- 1.0dBi on 2.4GHz



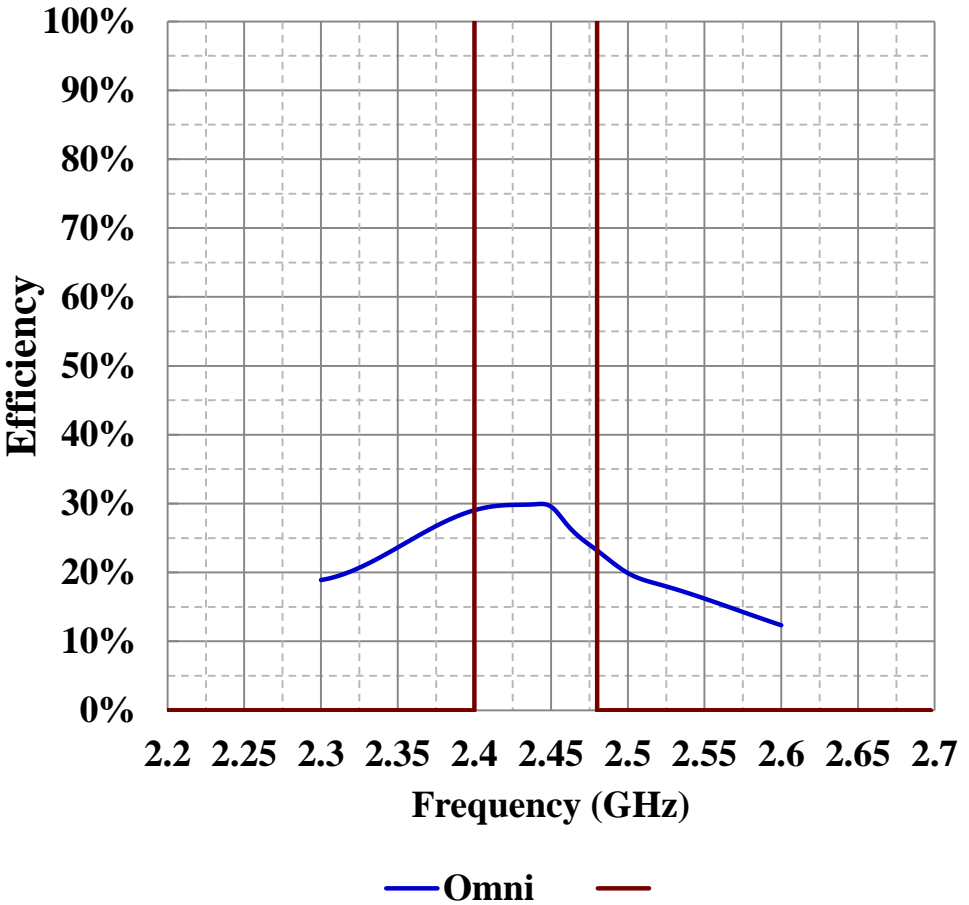
VSWR Omni Beam – P2A Sample



| 2.4GHz | Max | Mean | Min |
|--------|------|------|------|
| Omni | 1.89 | 1.36 | 1.02 |



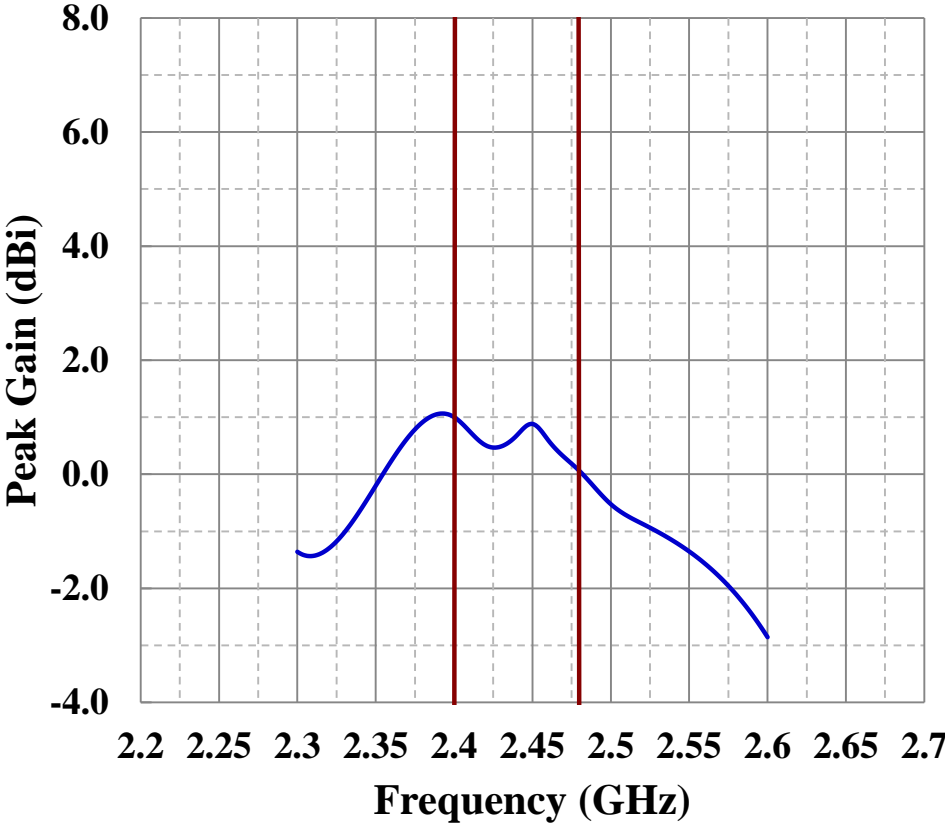
Efficiency Omni Beam – P2A Sample



| 2.4GHz | Max | Mean | Min |
|--------|-------|-------|-------|
| Omni | 29.9% | 28.4% | 23.6% |



Peak Gain Omni Beam – P2A Sample

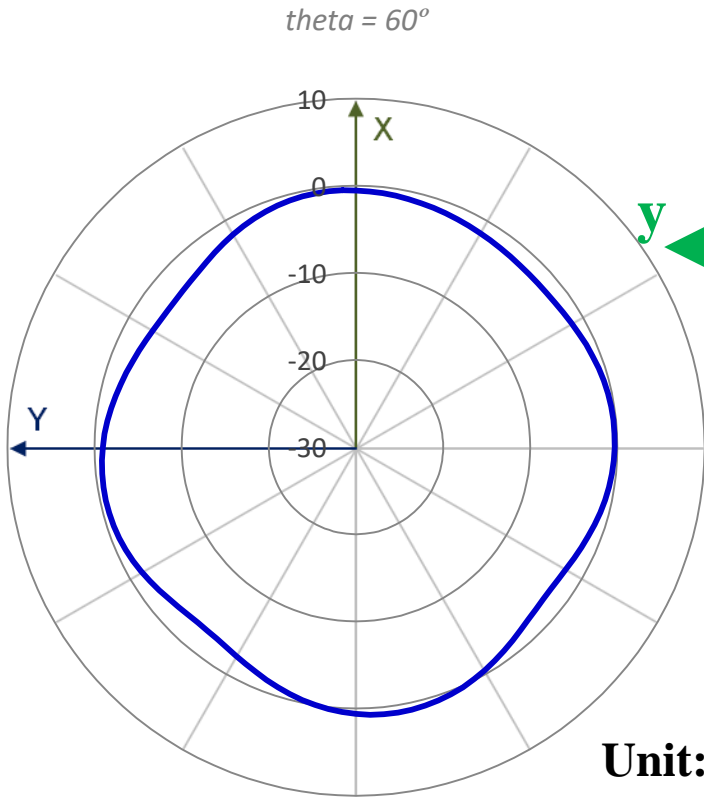
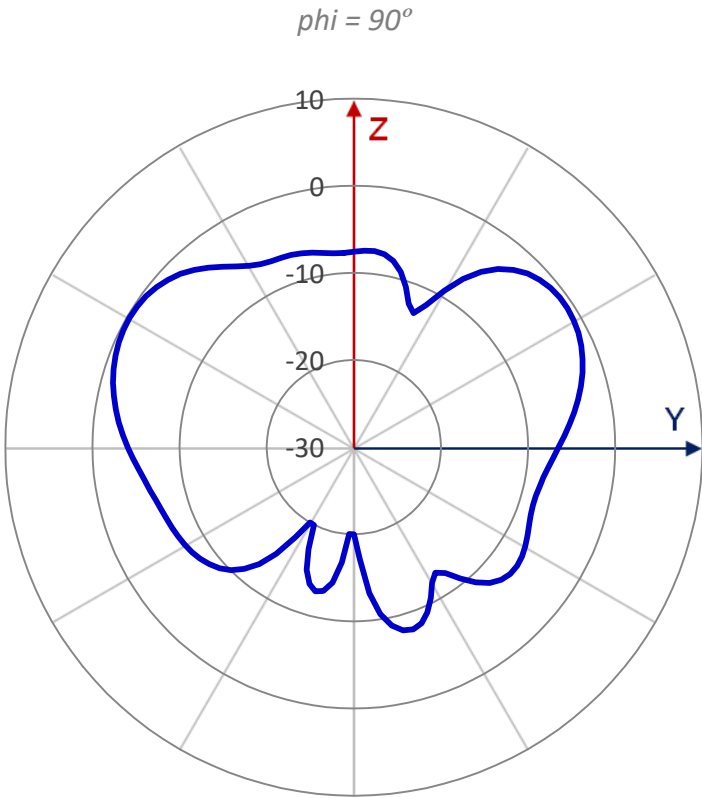
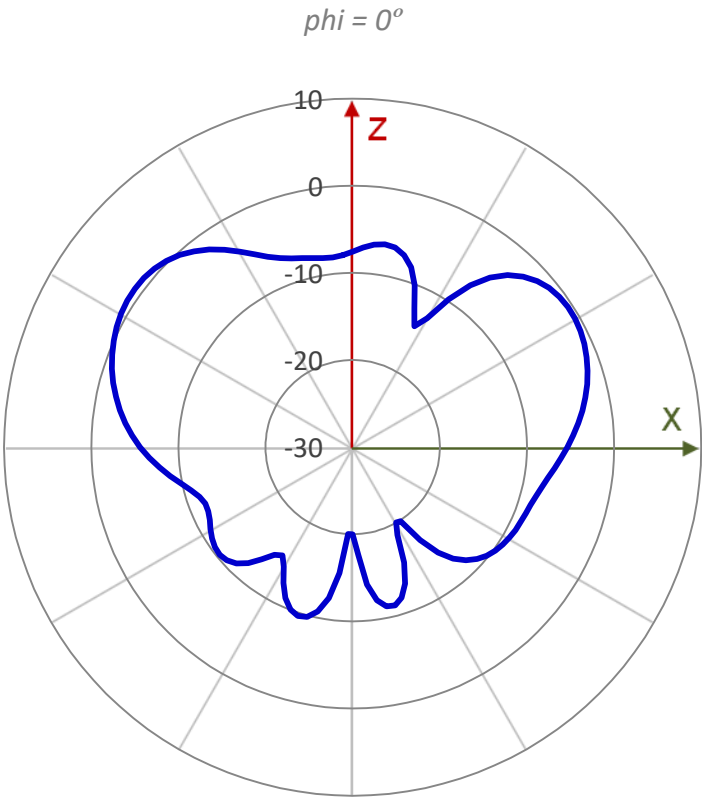


| 2.4GHz | Max | Mean | Min |
|--------|---------|---------|---------|
| Omni | 1.0 dBi | 0.6 dBi | 0.1 dBi |

— Omni —



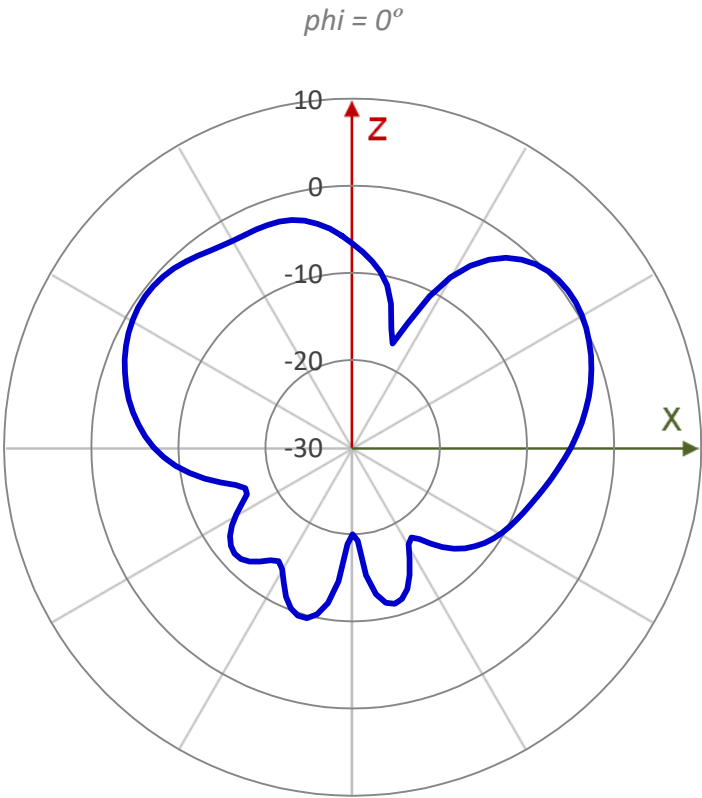
Realized Gain Pattern Omni Beam – P2A Sample @2400MHz for G_{total}



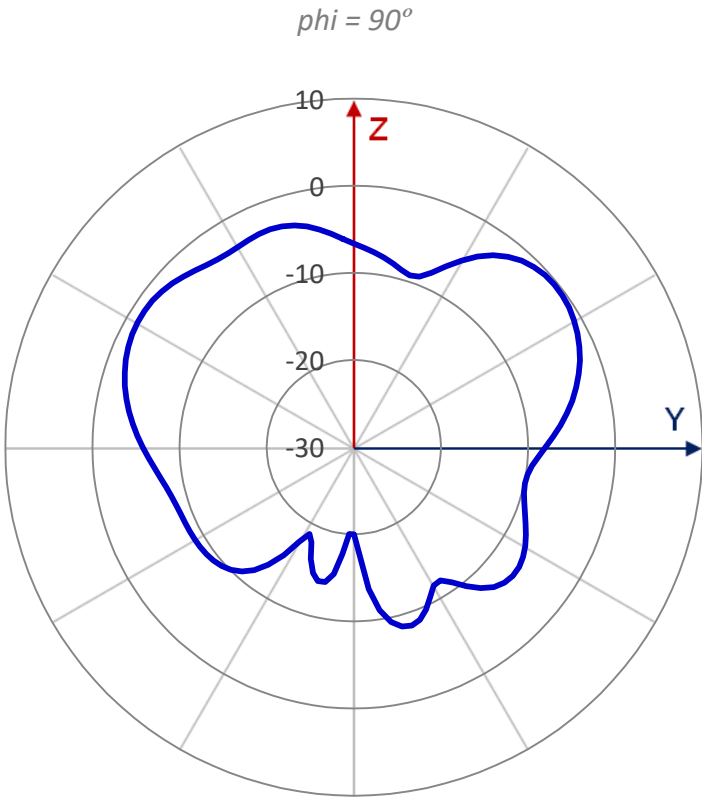
Unit: dBi



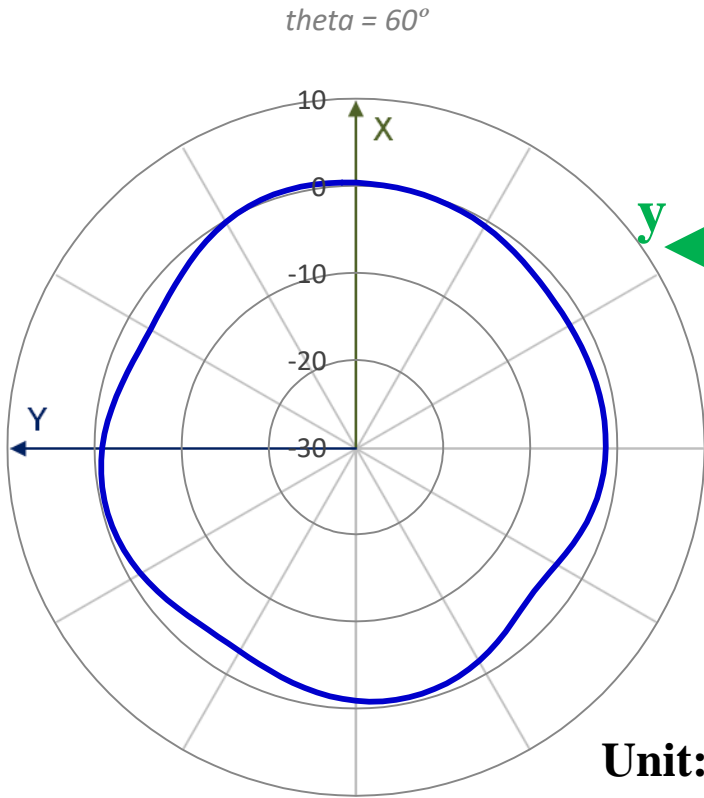
Realized Gain Pattern Omni Beam – P2A Sample @2440MHz for G_{total}



— Omni



— Omni

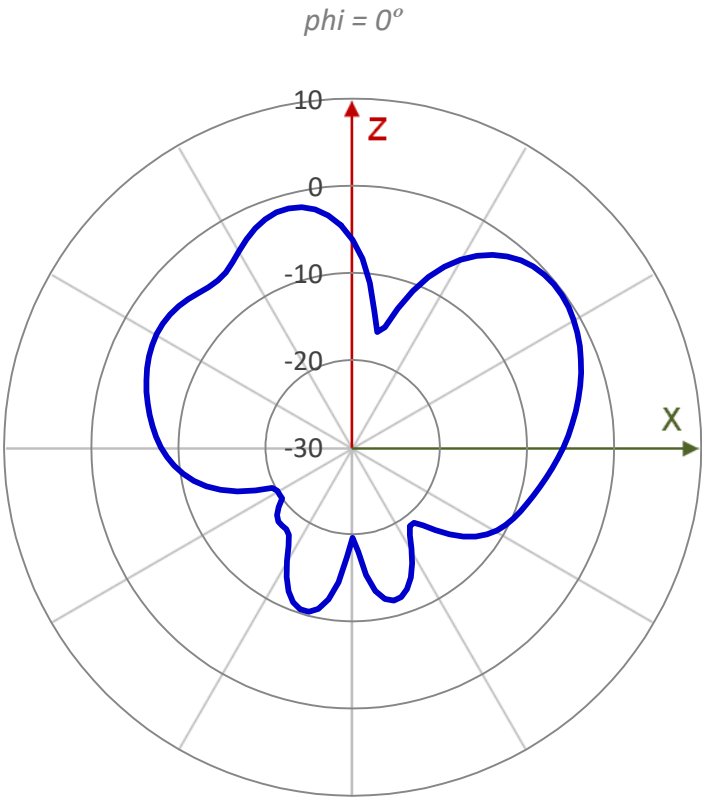


— Omni

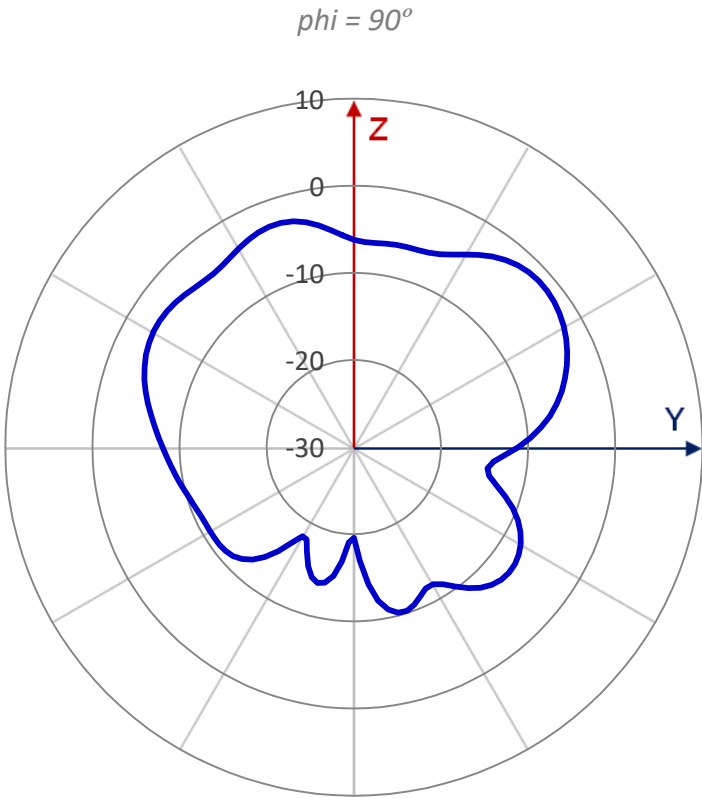
Unit: dBi



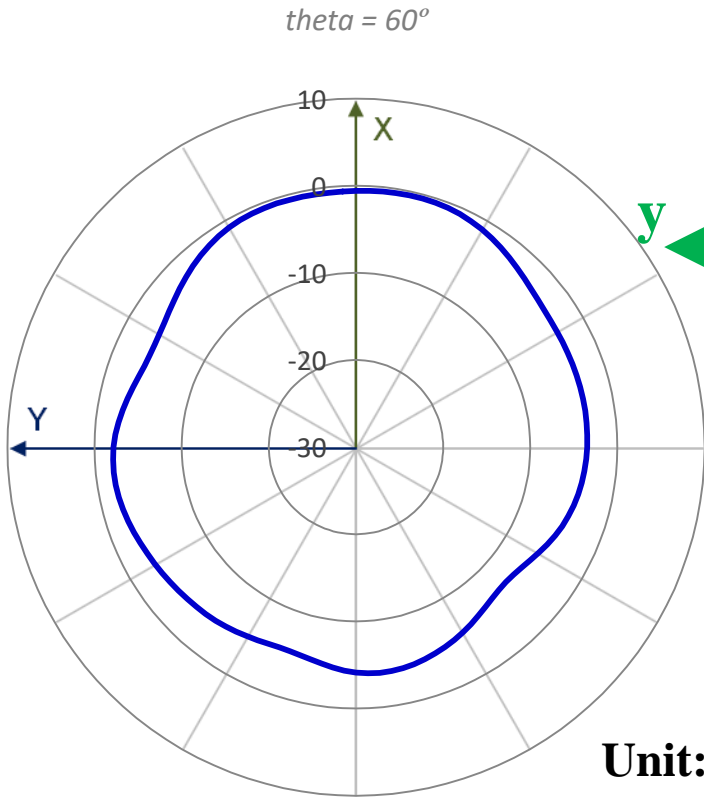
Realized Gain Pattern Omni Beam – P2A Sample @2480MHz for G_{total}



— Omni



— Omni



— Omni

Unit: dBi

