

Jewel AP Antenna Testing Report P2A Sample

Provided by Patrick Tsai

Roye Chen

2021/08/19



- **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

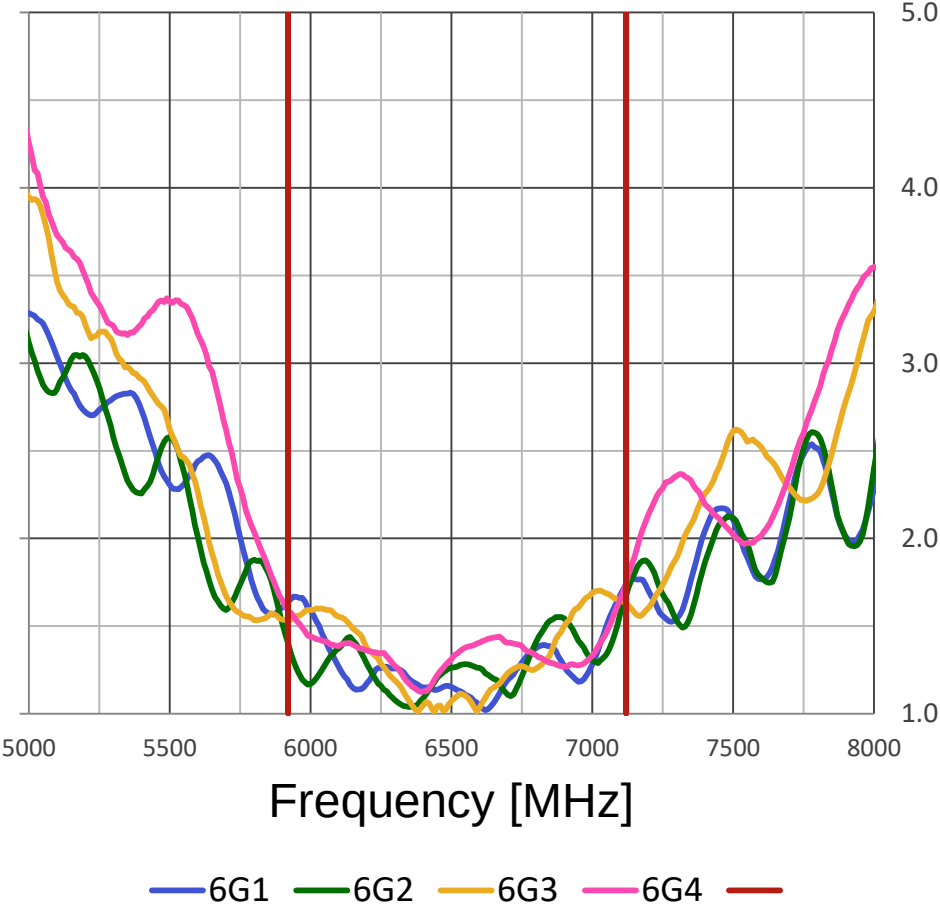
	2450 MHz	5150 MHz	5450 MHz	5850 MHz	5925 MHz	6565 MHz	7125 MHz
SC1	4.2 dBi	5.4 dBi	5.0 dBi	5.1 dBi	4.7 dBi	4.8 dBi	4.1 dBi
SC2	5.0 dBi	4.0 dBi	5.5 dBi	5.3 dBi	4.4 dBi	4.7 dBi	3.8 dBi
Composite	5.87 dBi	7.41 dBi	7.05 dBi	7.72 dBi	7.42 dBi	6.83 dBi	6.36 dBi

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



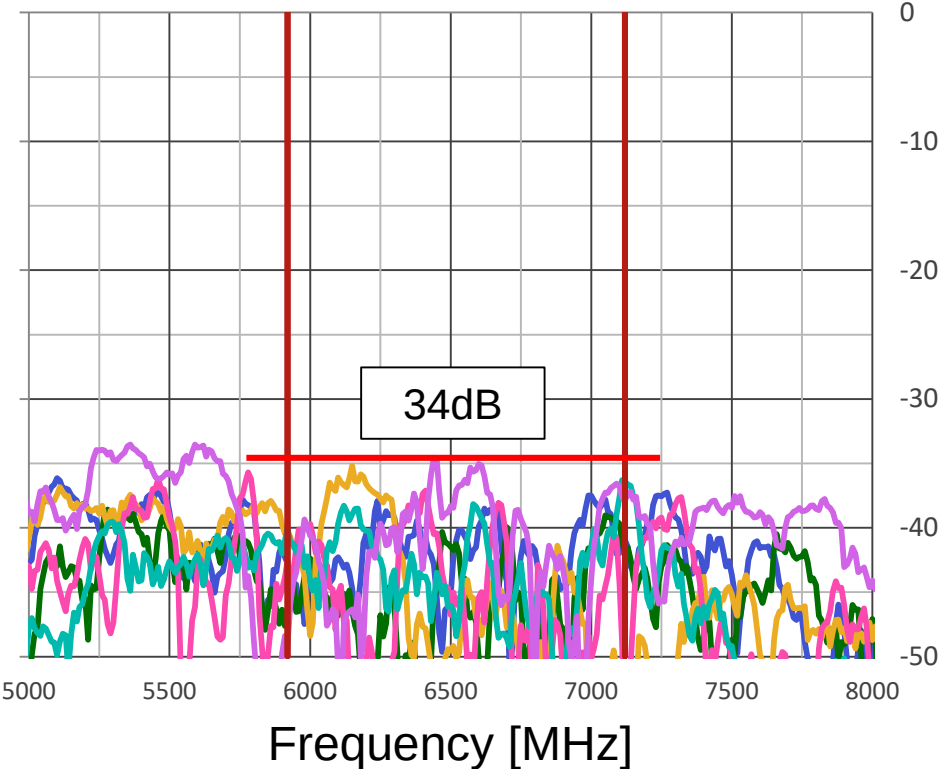
VSWR Single 6G



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

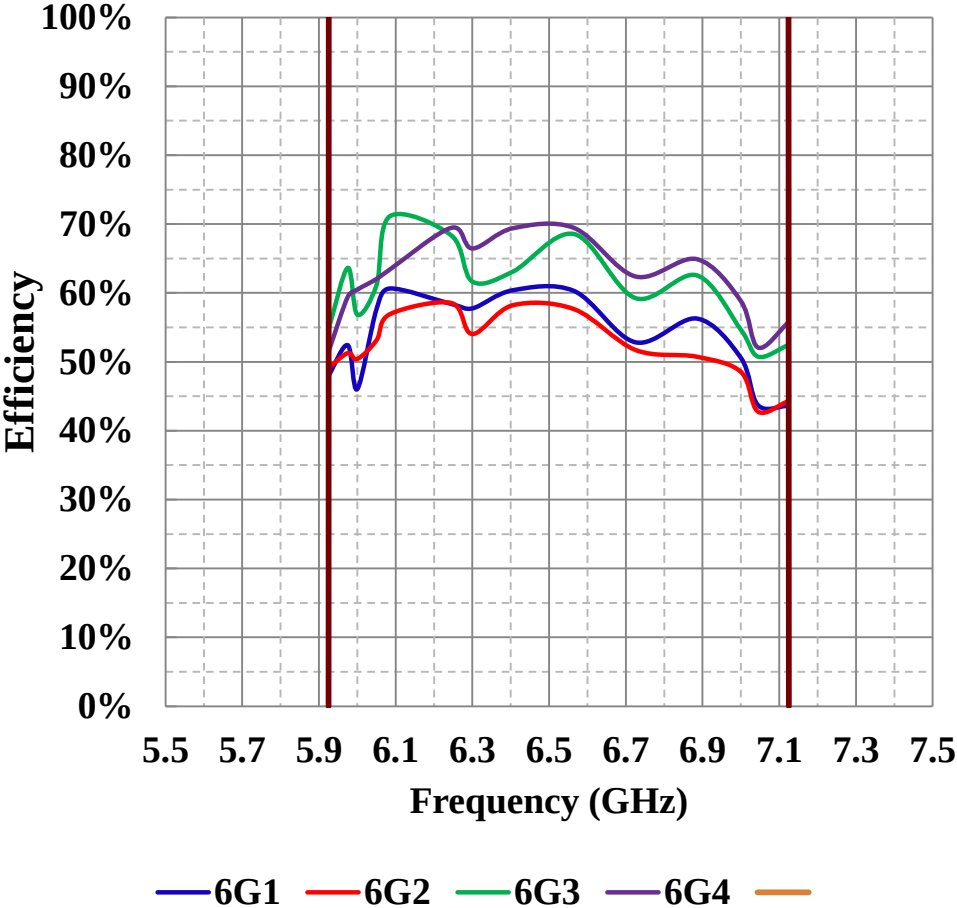


6G1_6G2 6G1_6G3 6G1_6G4 6G2_6G3
6G2_6G4 6G3_6G4

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

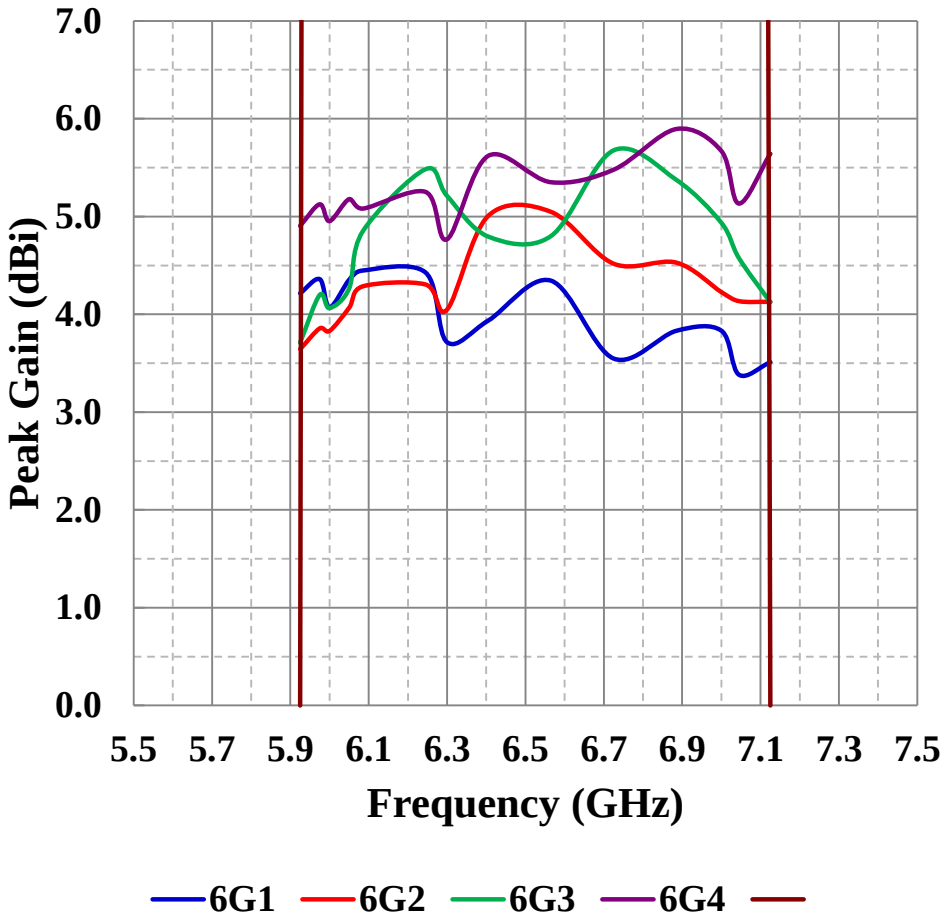
6G2 : 329mm

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

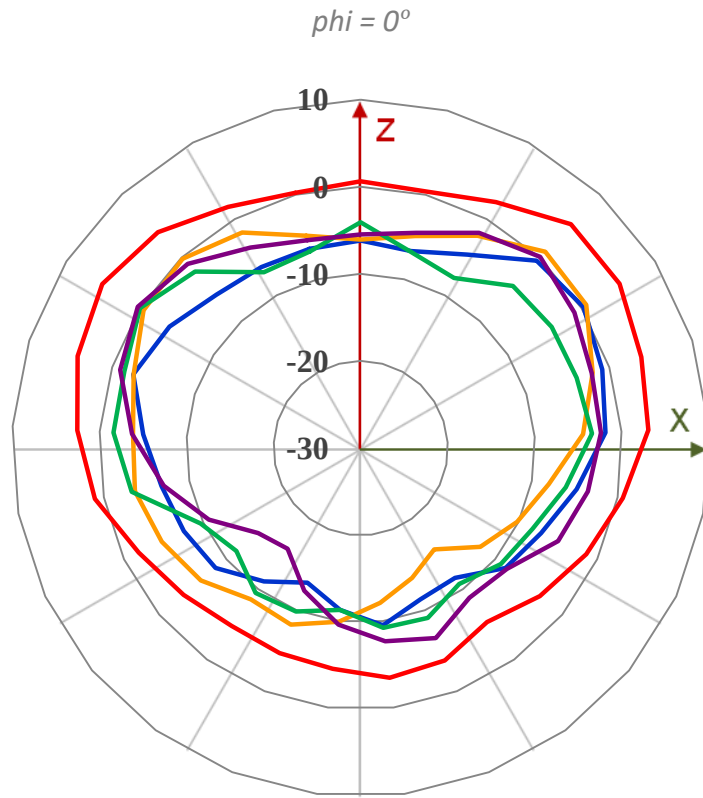
6G2 : 329mm

6G3 : 160mm

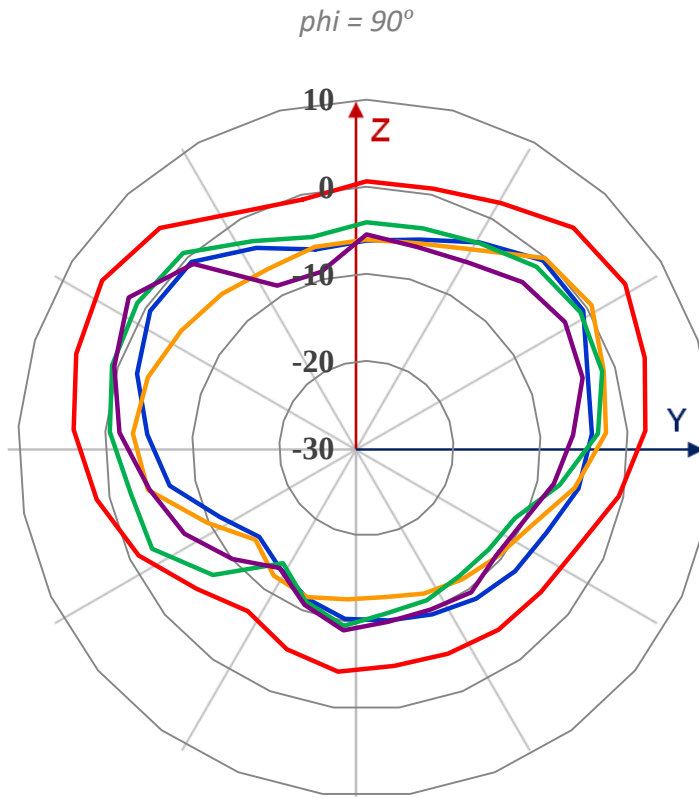
6G4 : 136mm



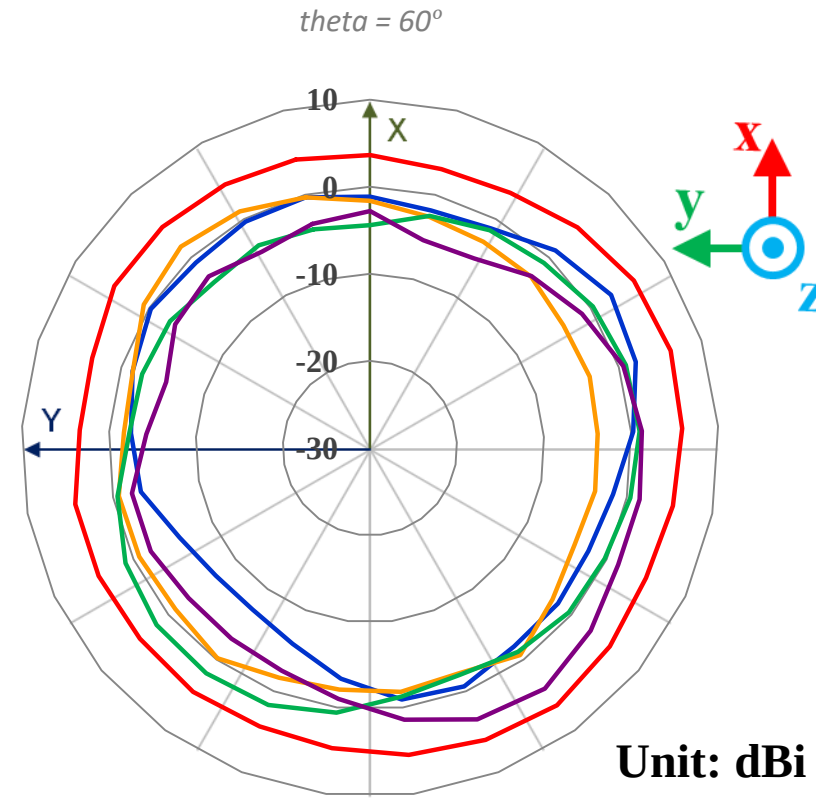
Realized Gain Pattern Single 6G @5925MHz for G_{total}



— 6G1 — 6G2 — 6G3
— 6G4 — Composite



— 6G1 — 6G2 — 6G3
— 6G4 — Composite

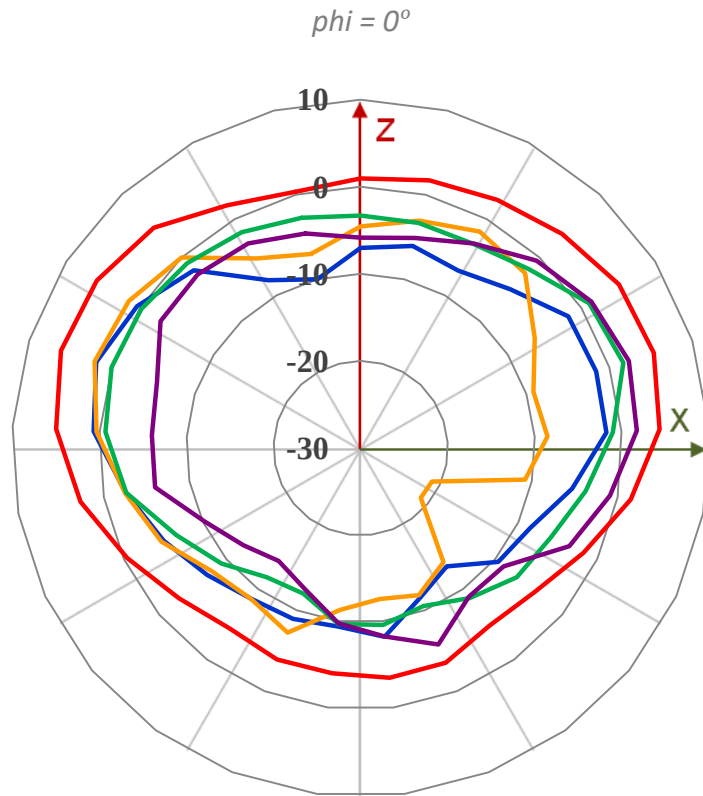


— 6G1 — 6G2 — 6G3
— 6G4 — Composite

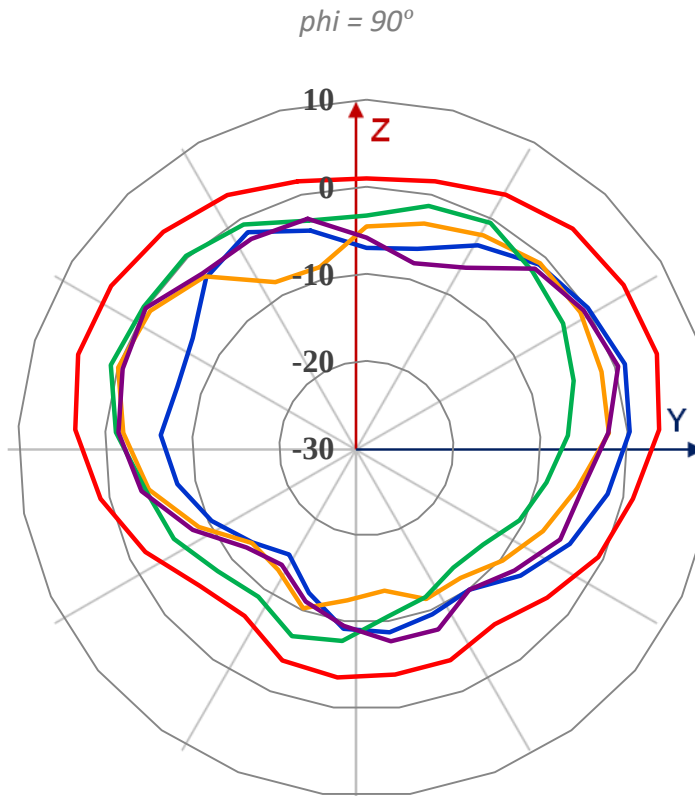
Unit: dBi



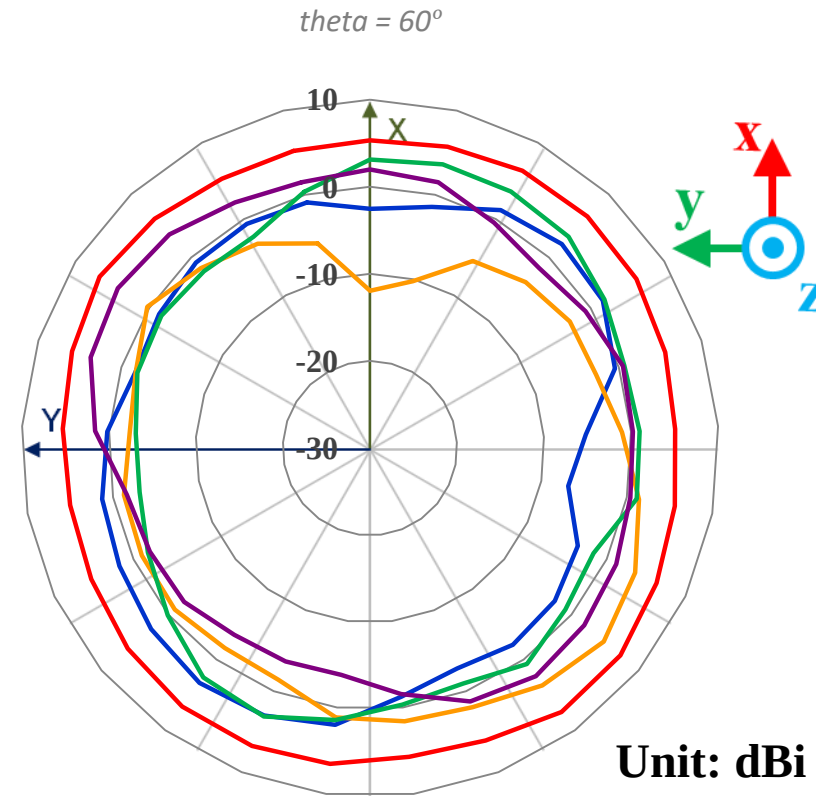
Realized Gain Pattern Single 6G @6565MHz for G_{total}



— 6G1 — 6G2 — 6G3
— 6G4 — Composite

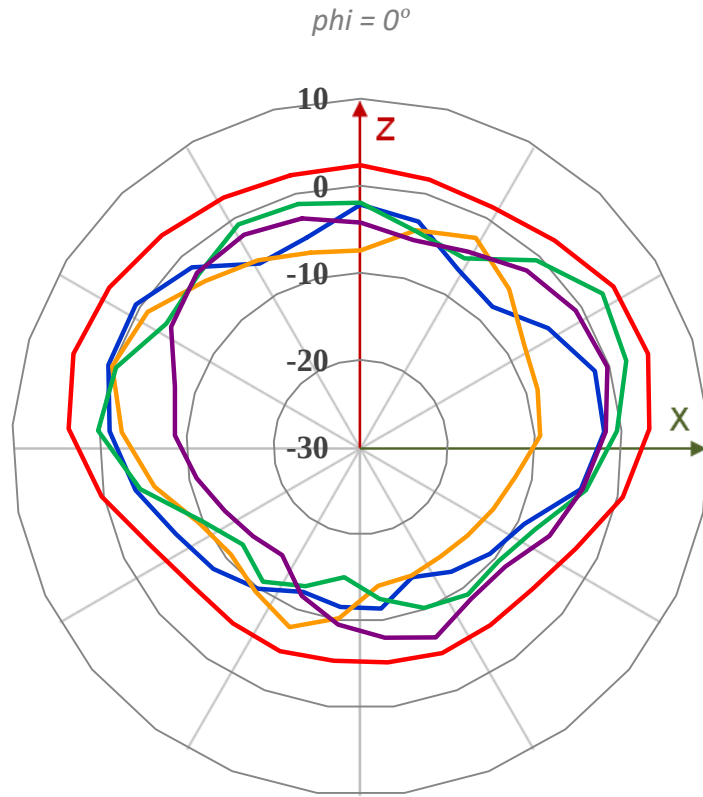


— 6G1 — 6G2 — 6G3
— 6G4 — Composite

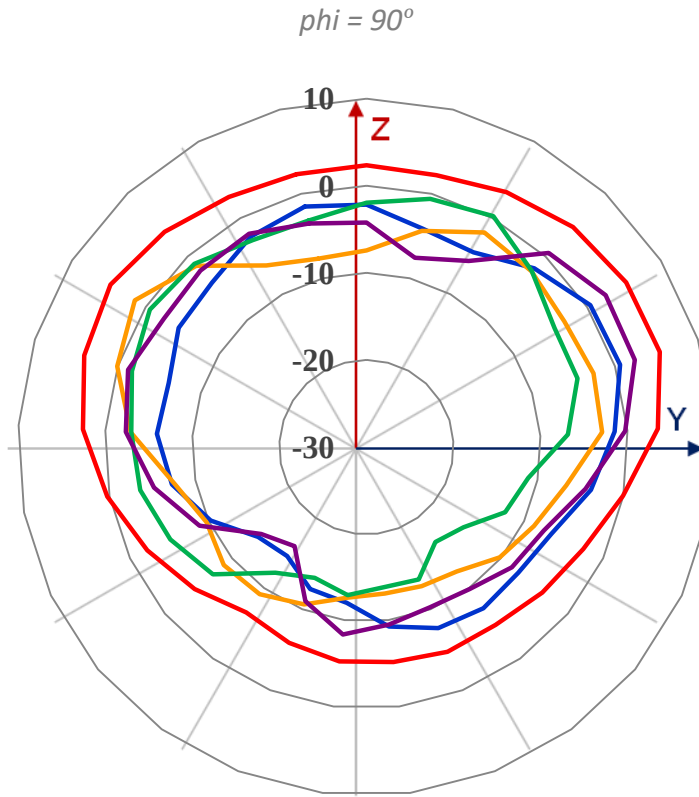


— 6G1 — 6G2 — 6G3
— 6G4 — Composite

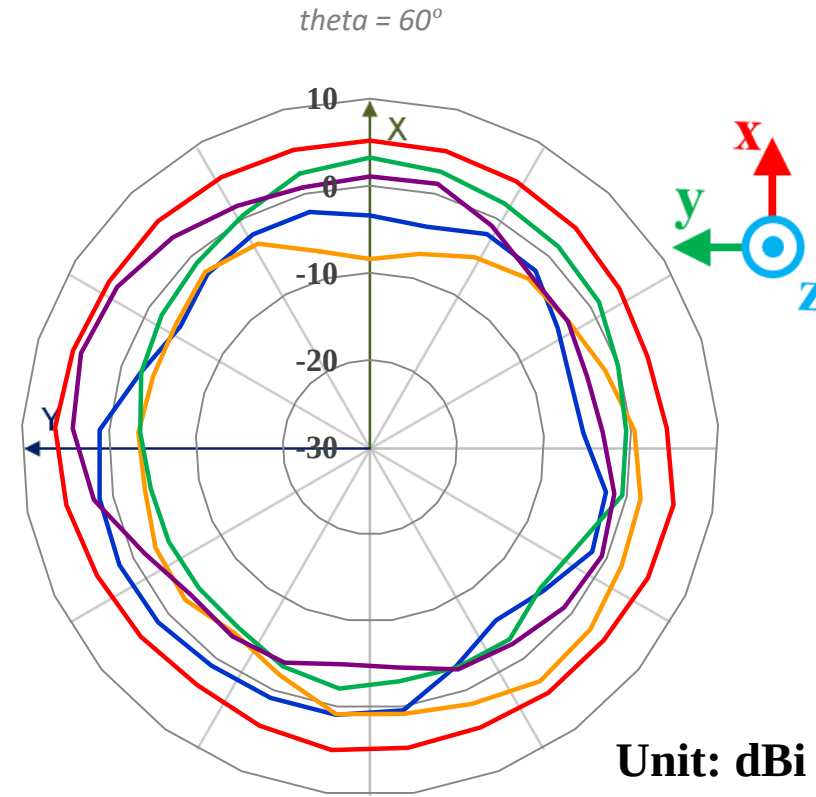
Realized Gain Pattern Single 6G @7125MHz for G_{total}



— 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**

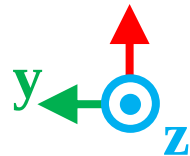
- 5.0dBi on 2.4GHz / 5.8dBi on 5GHz

- **Cable Length**

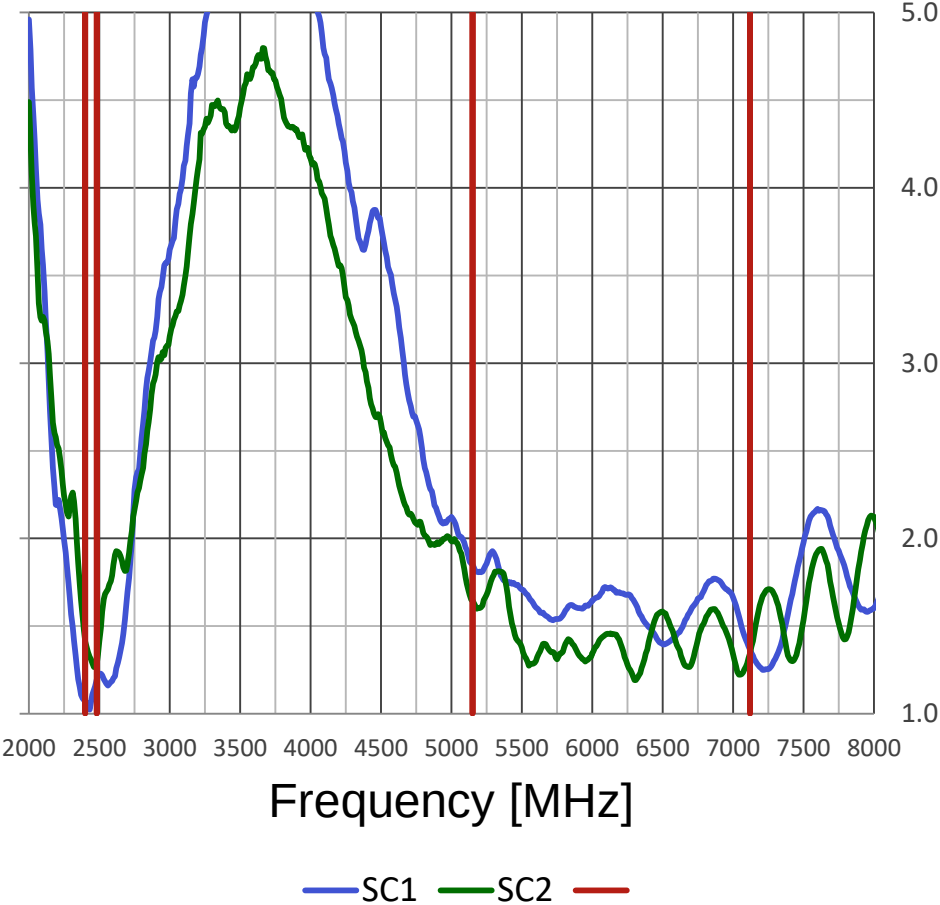
- SC1 : 121 mm

- SC2 : 259mm

X



VSWR Scanning

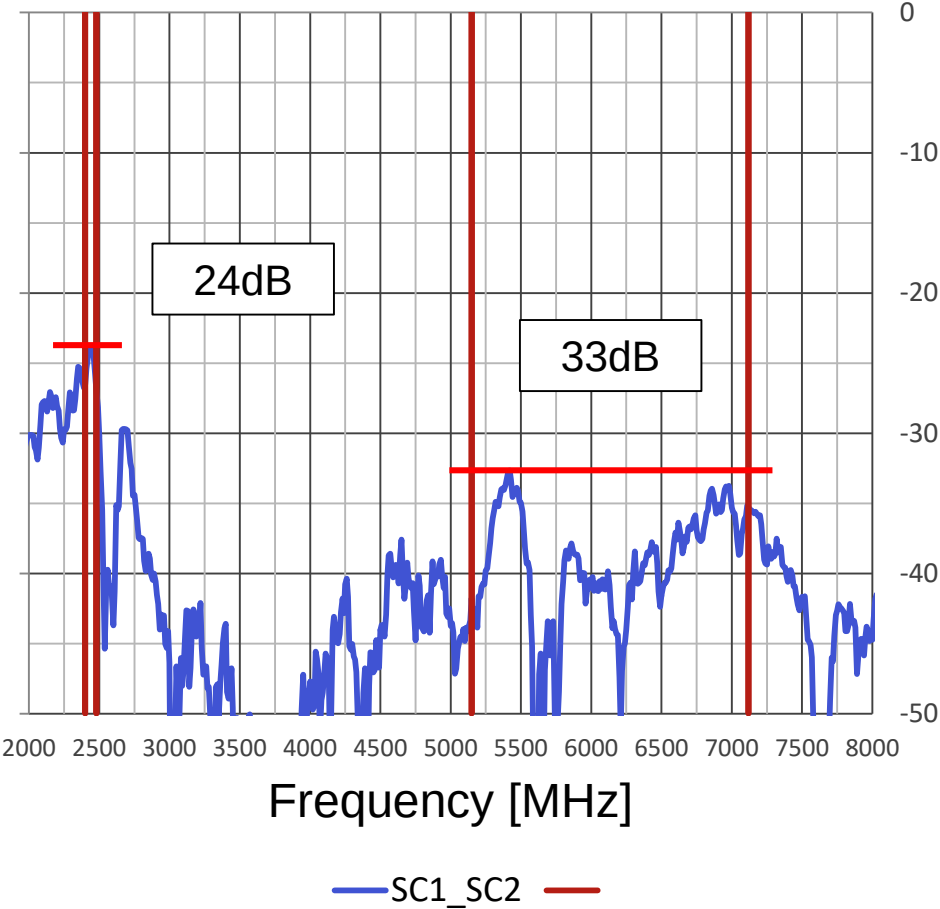


2.4GHz	Max	Mean	Min
SC1	1.2	1.1	1.0
SC2	1.4	1.3	1.3
Summary	1.4	1.2	1.0

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

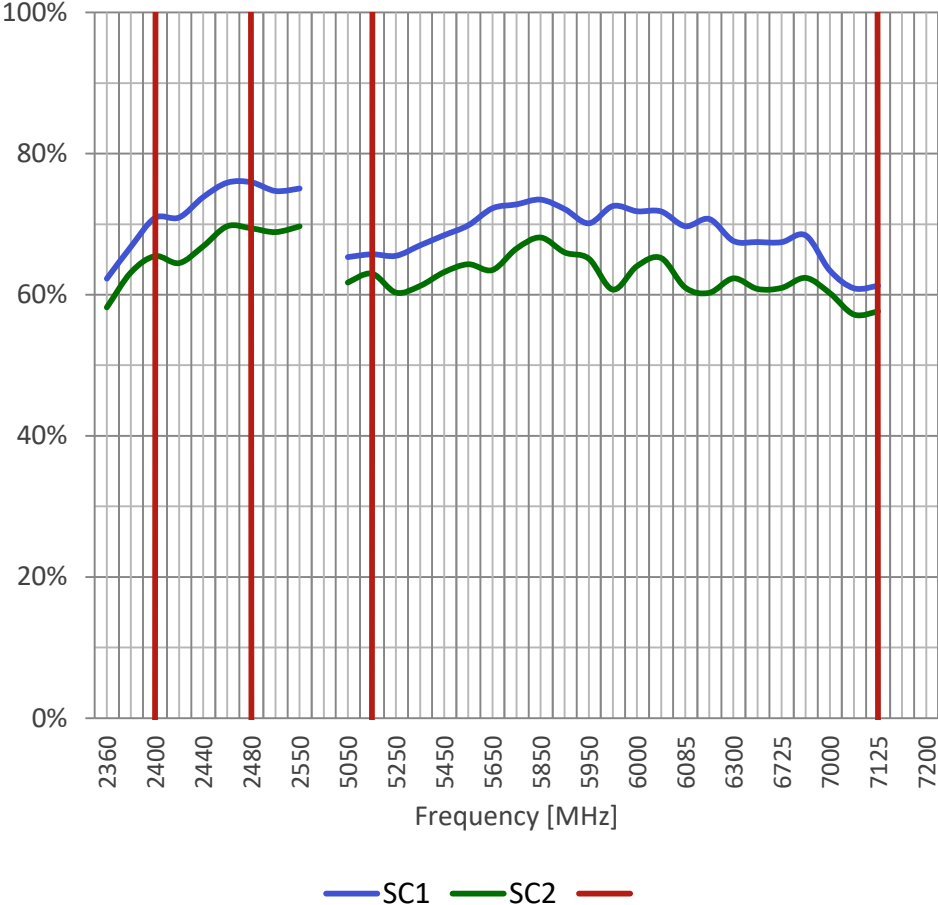


2.4GHz	Max	Mean	Min
SC1_SC2	-23.8	-25.0	-27.0

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 %

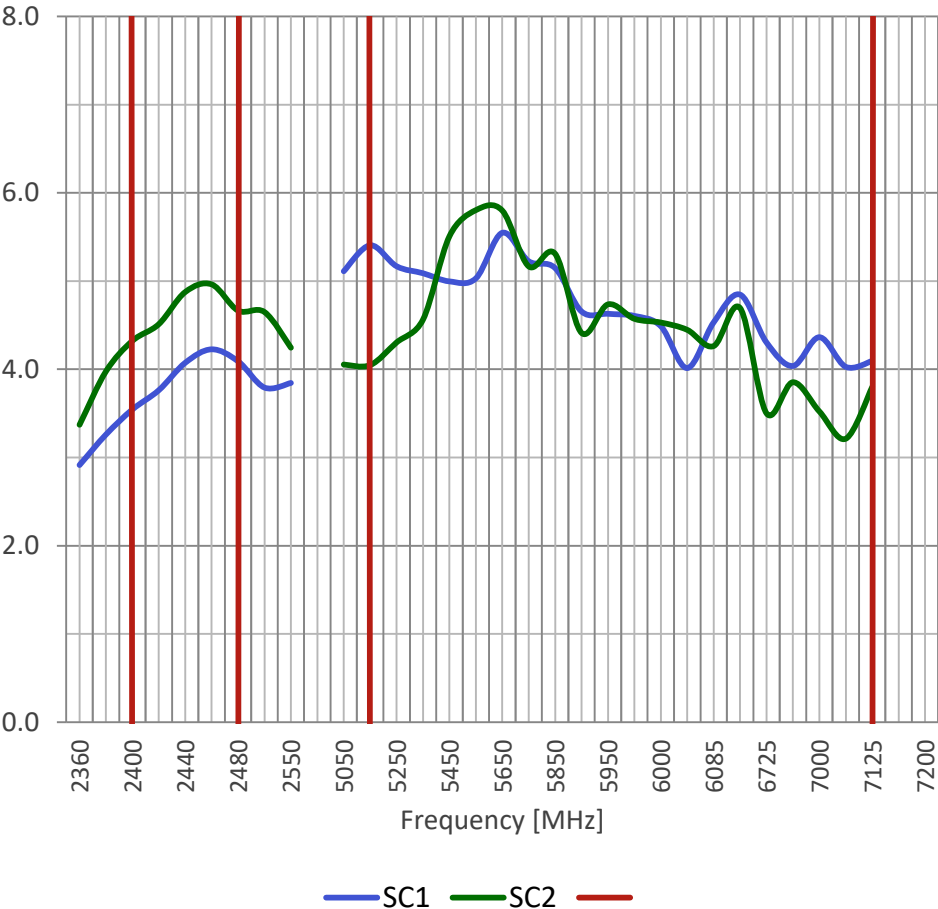
■ Cable Length

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

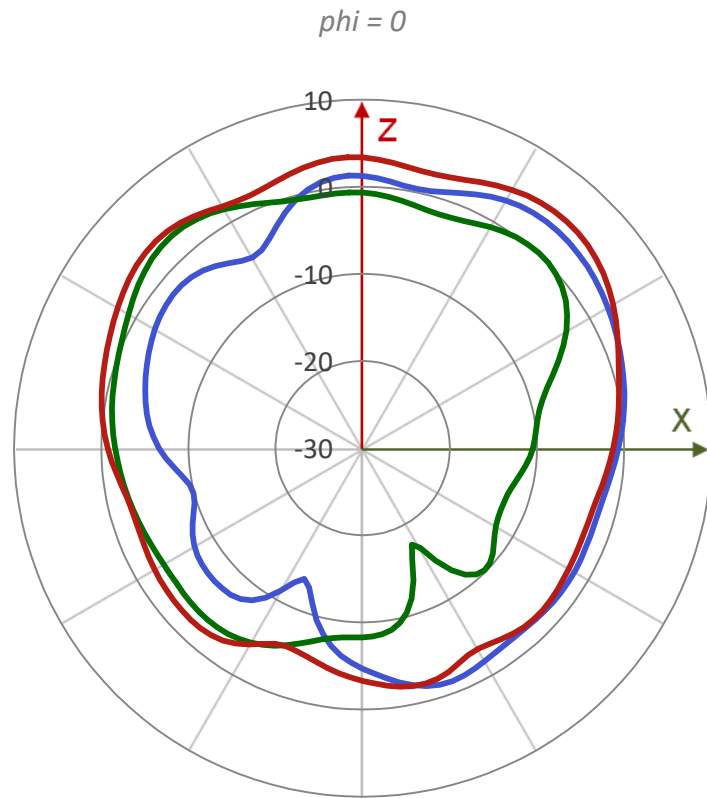
■ Cable Length

SC1 : 121 mm

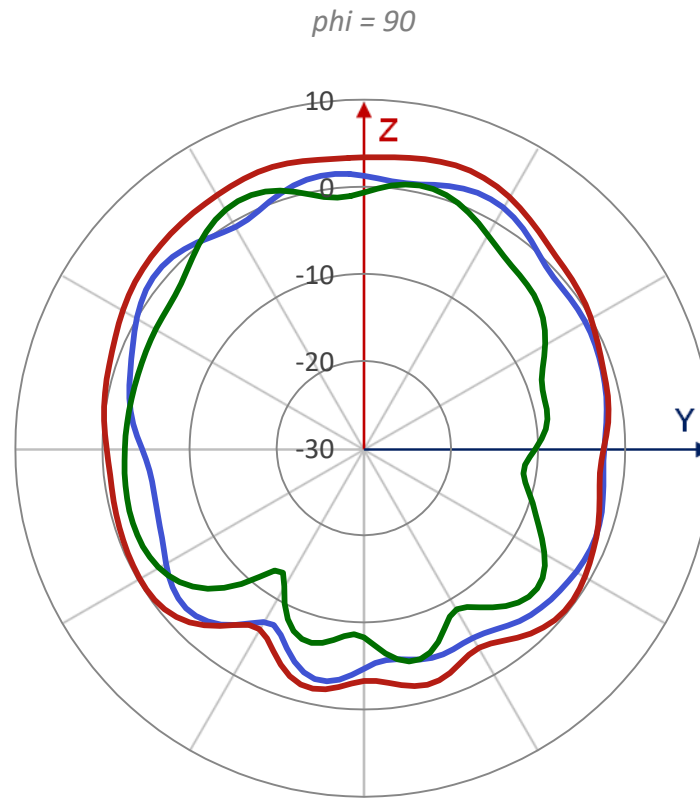
SC2 : 259mm



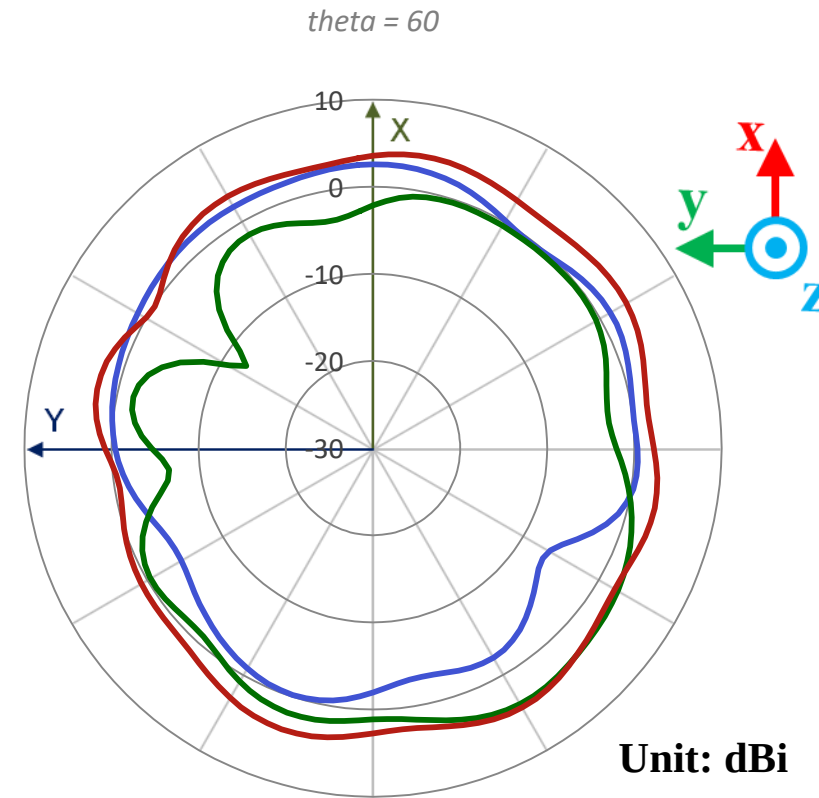
Realized Gain Pattern Scanning @2400MHz for Gtotal



— SC1 — SC2 — Composite



— SC1 — SC2 — Composite

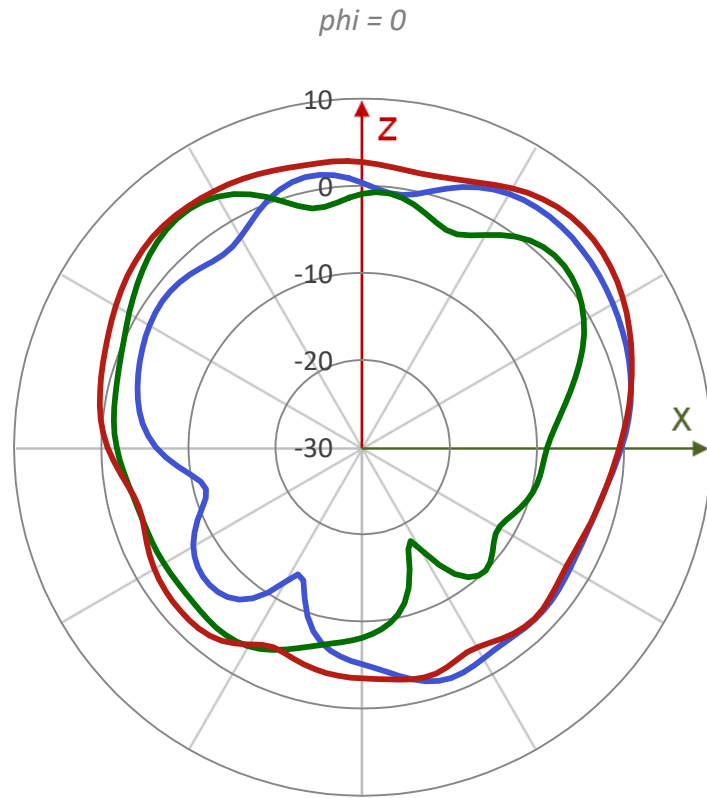


— SC1 — SC2 — Composite

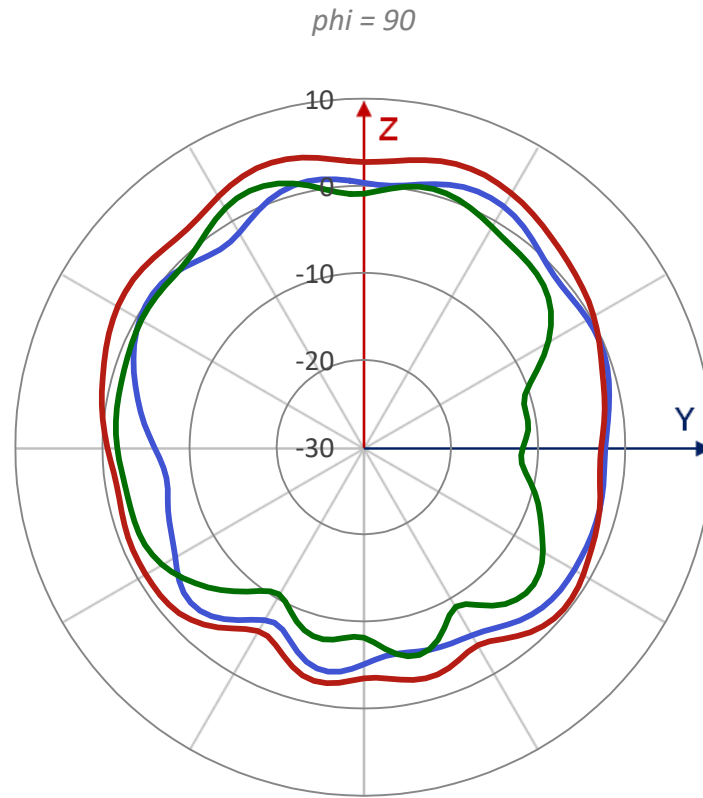
Unit: dBi



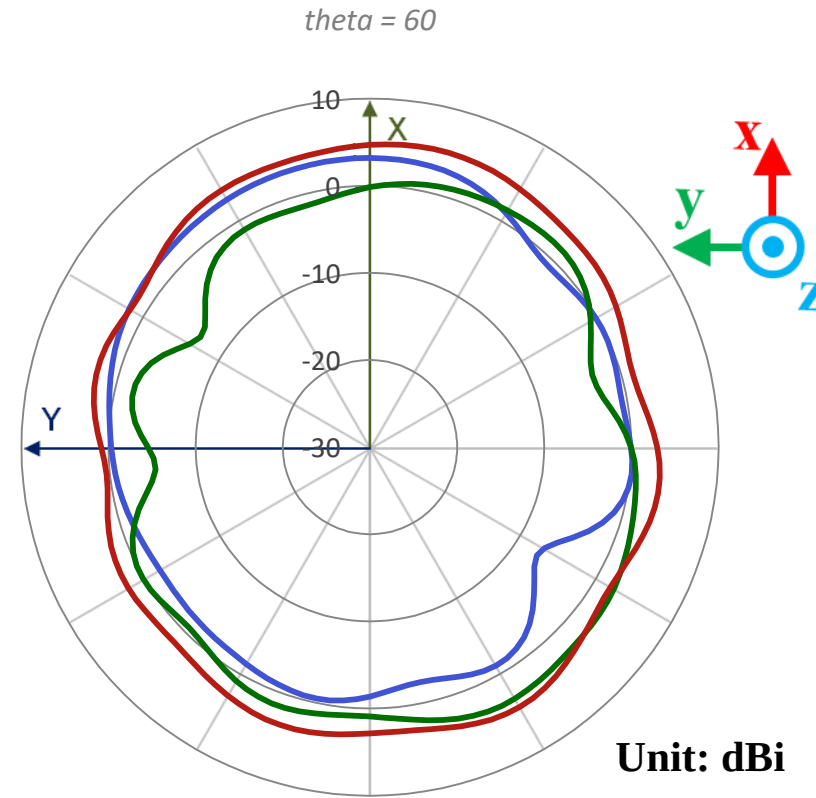
Realized Gain Pattern Scanning @2440MHz for Gtotal



— SC1 — SC2 — Composite



— SC1 — SC2 — Composite

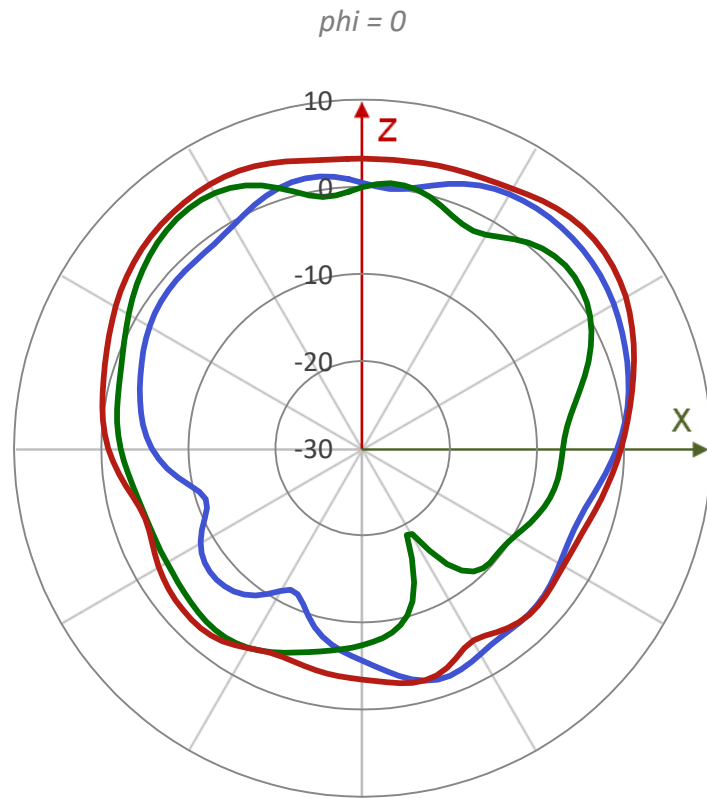


— SC1 — SC2 — Composite

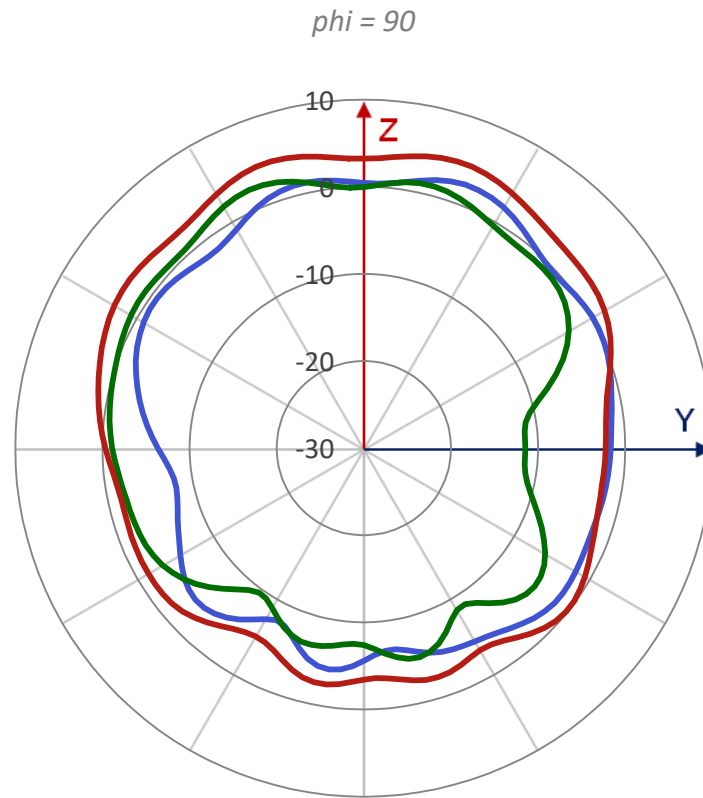
Unit: dBi



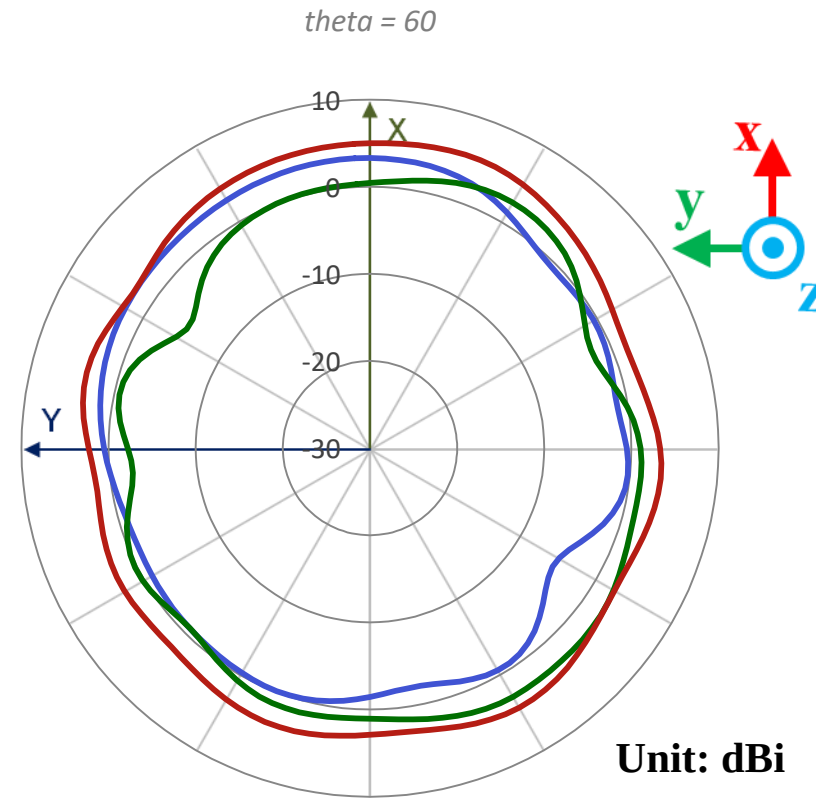
Realized Gain Pattern Scanning @2480MHz for Gtotal



— SC1 — SC2 — Composite



— SC1 — SC2 — Composite

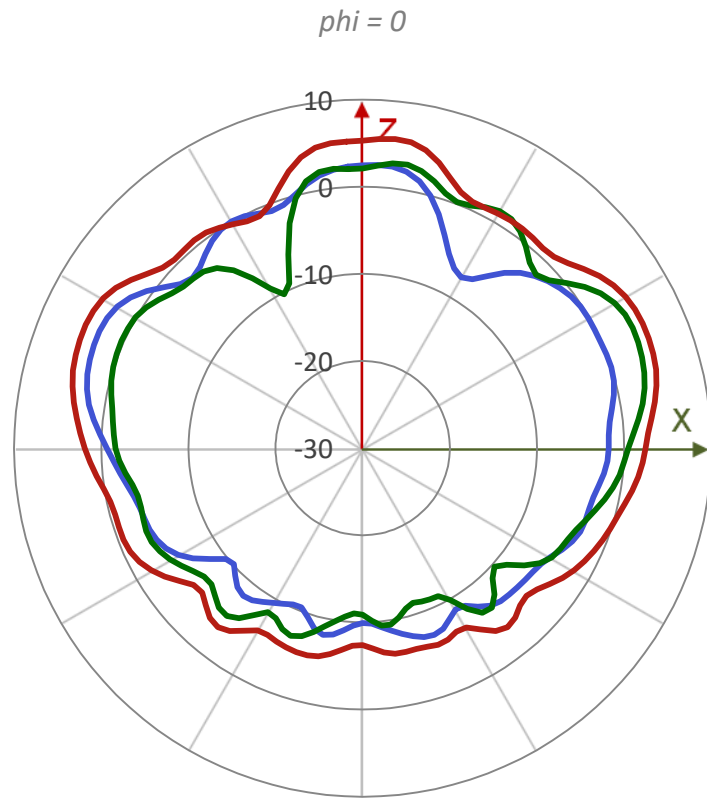


— SC1 — SC2 — Composite

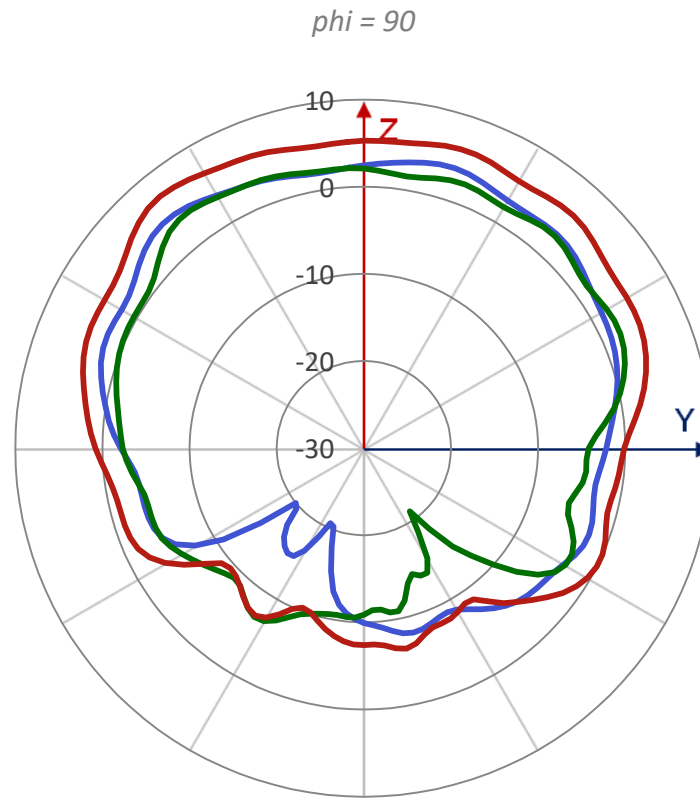
Unit: dBi



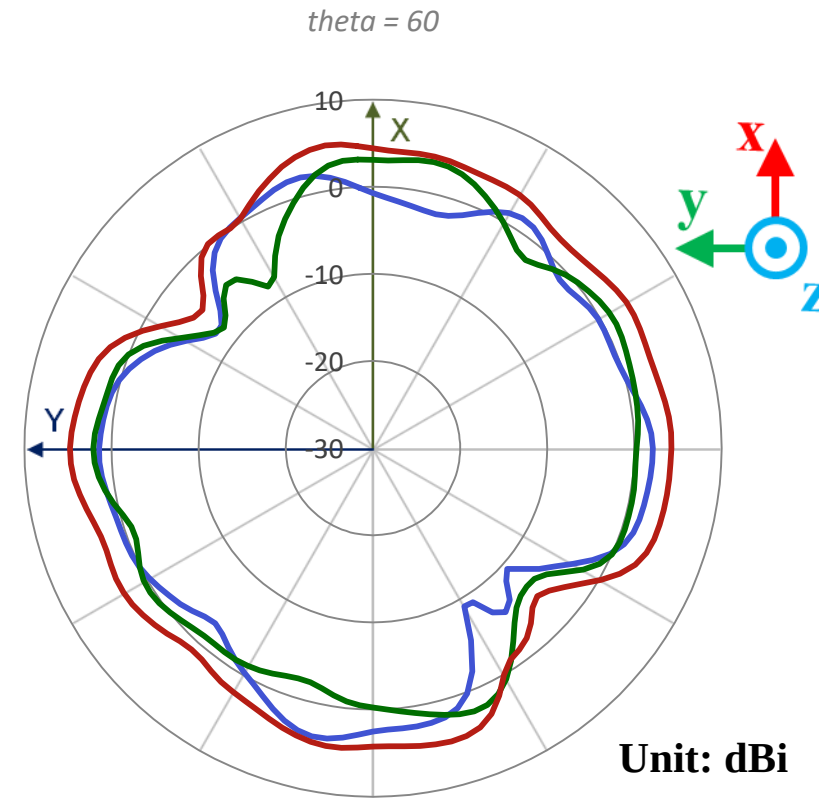
Realized Gain Pattern Scanning @5150MHz for Gtotal



— SC1 — SC2 — Composite



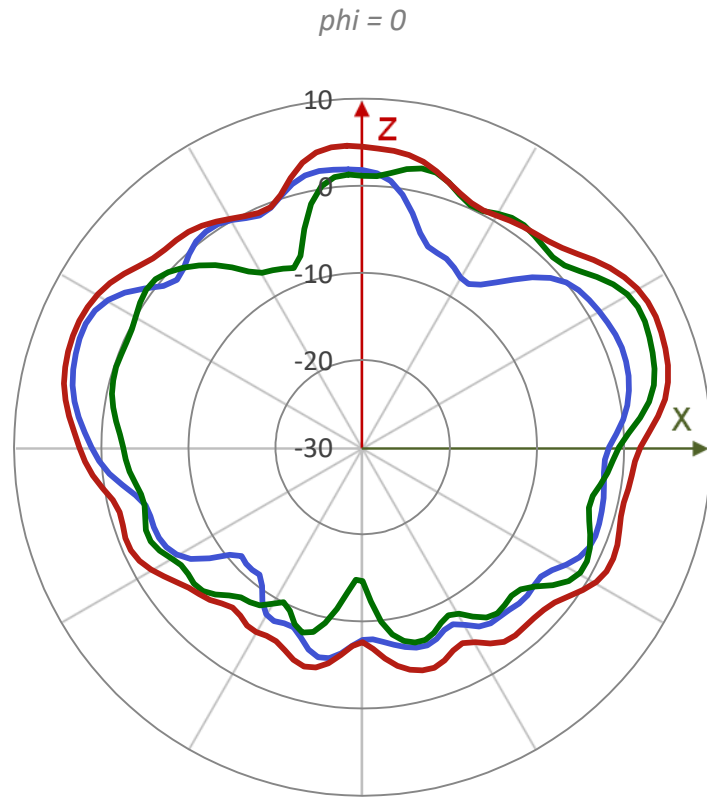
— SC1 — SC2 — Composite



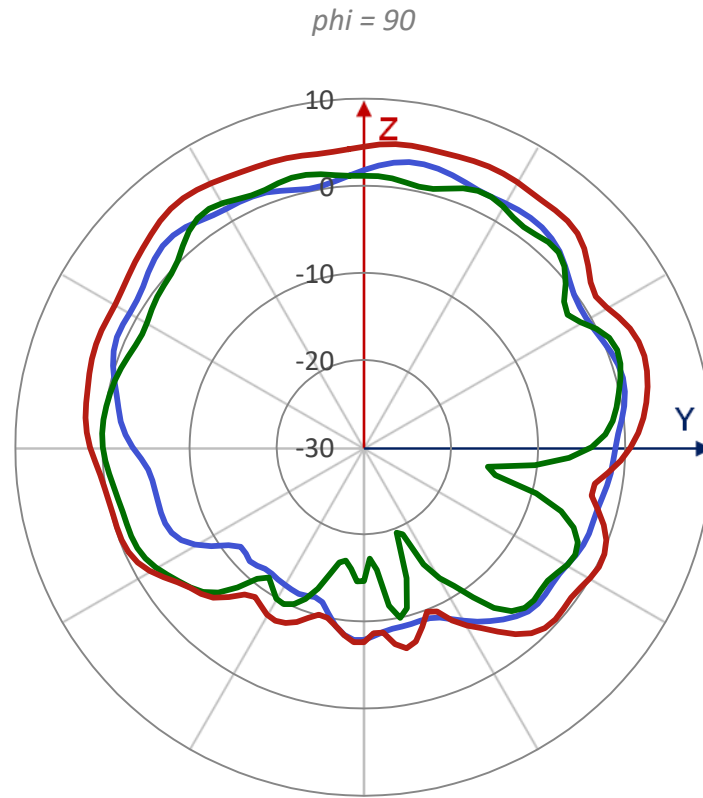
— SC1 — SC2 — Composite

Unit: dBi

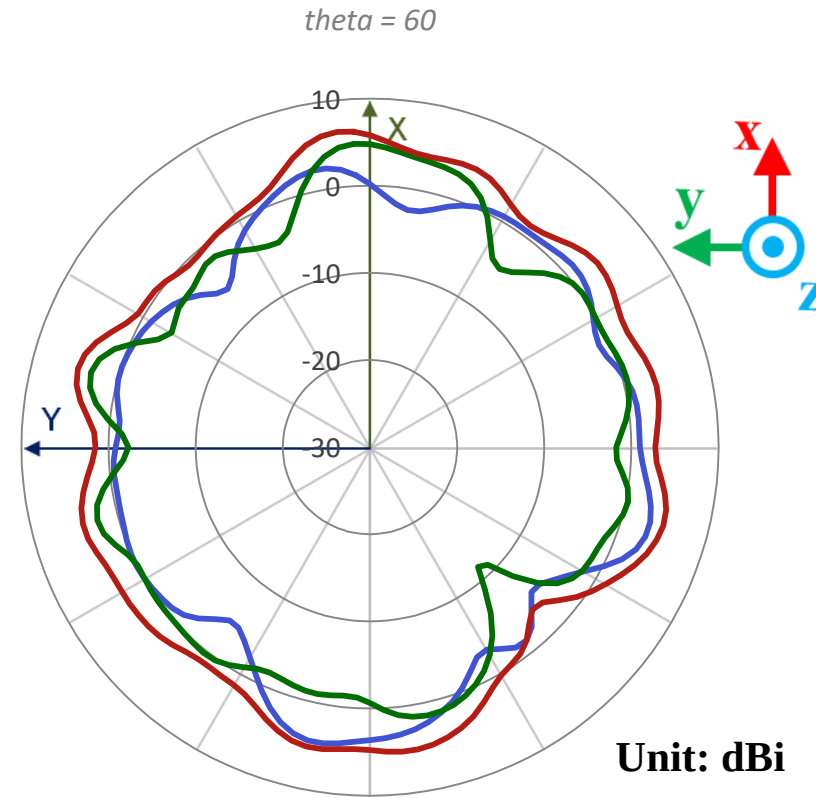
Realized Gain Pattern Scanning @5450MHz for Gtotal



— SC1 — SC2 — Composite



— SC1 — SC2 — Composite

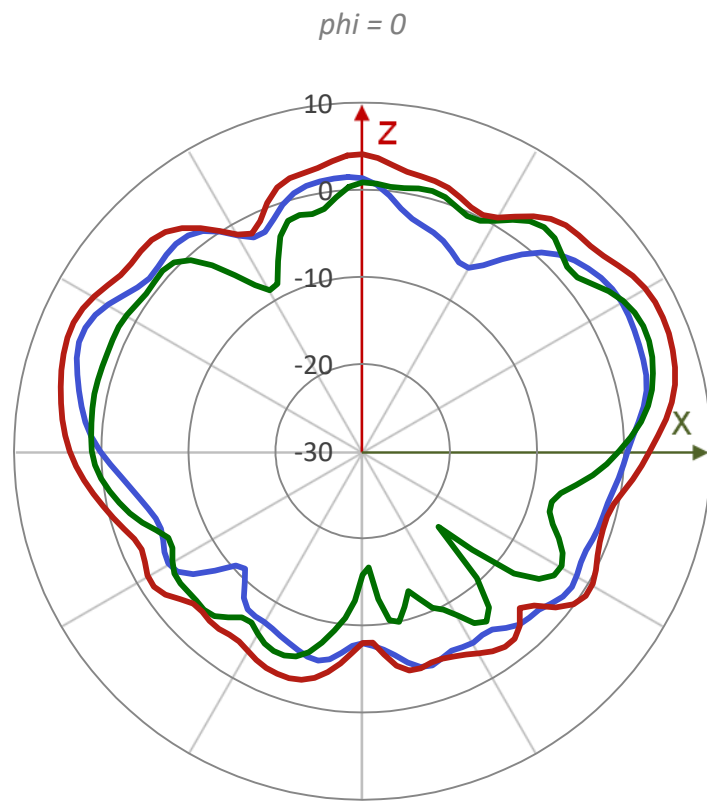


— SC1 — SC2 — Composite

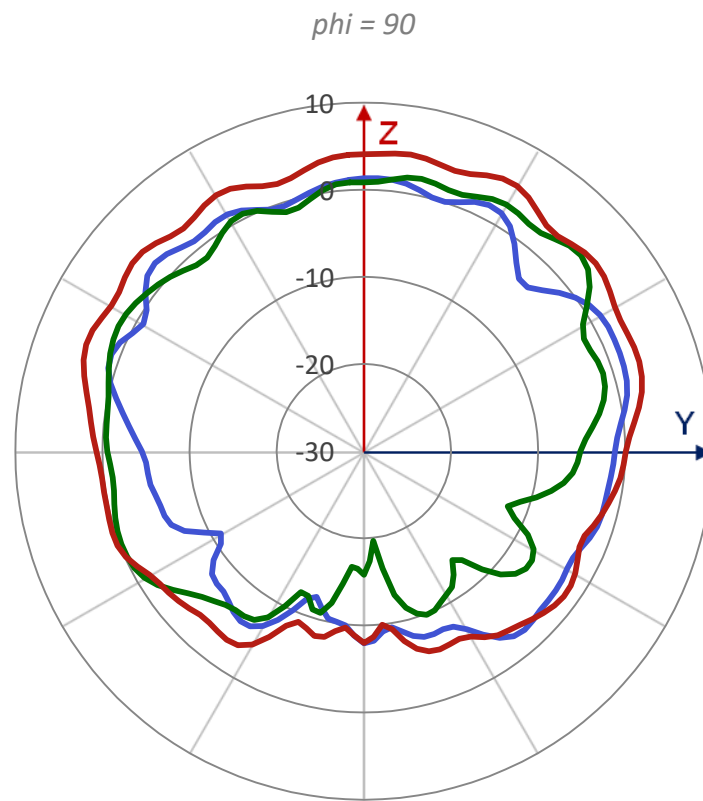
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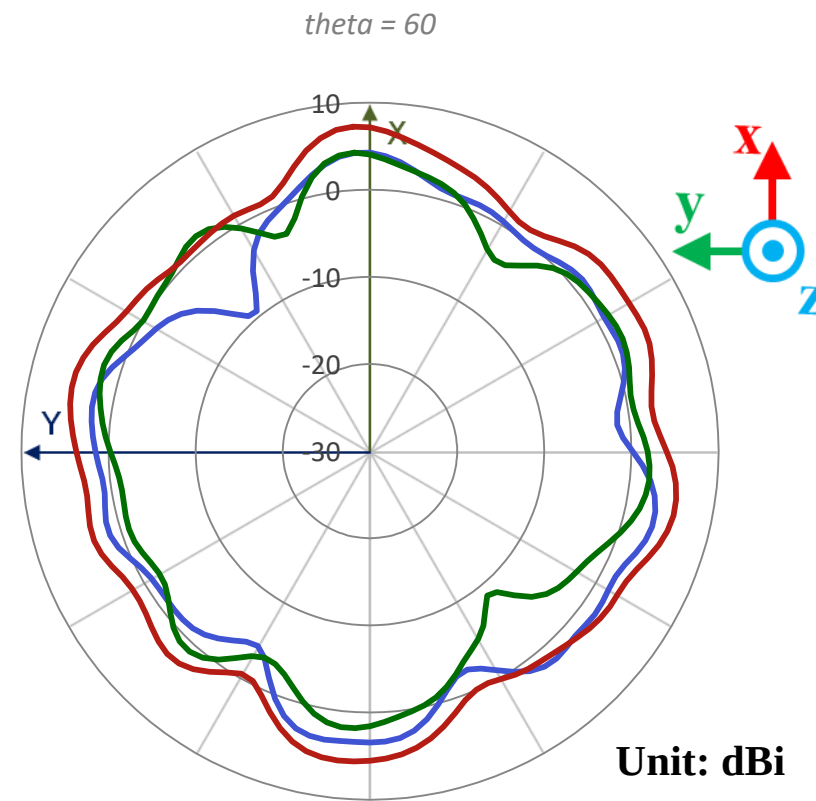
Realized Gain Pattern Scanning @5850MHz for Gtotal



— SC1 — SC2 — Composite

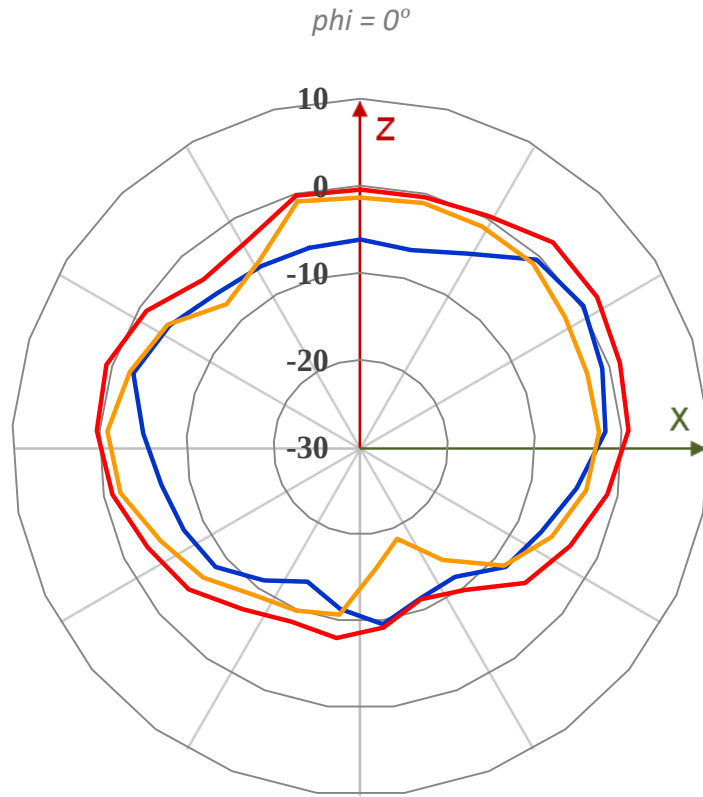


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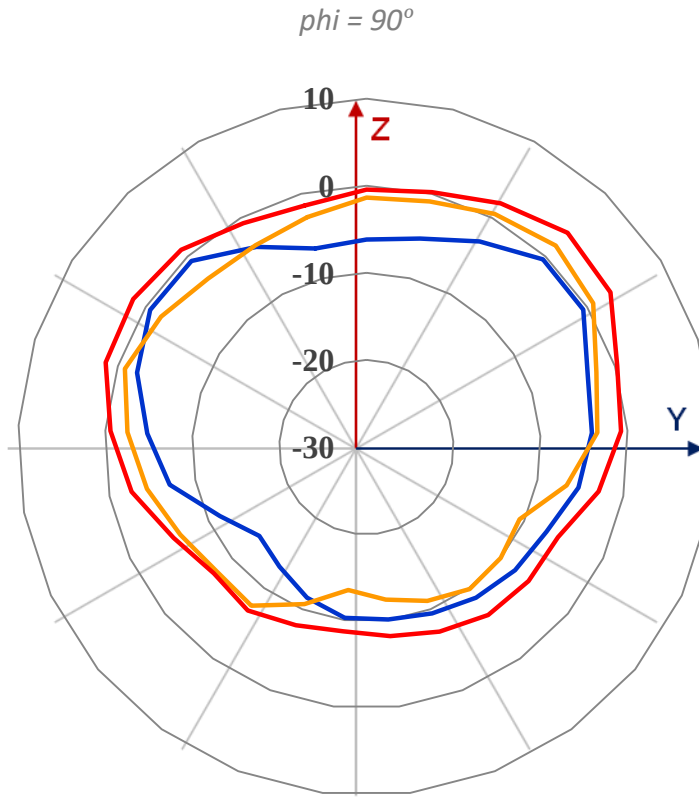


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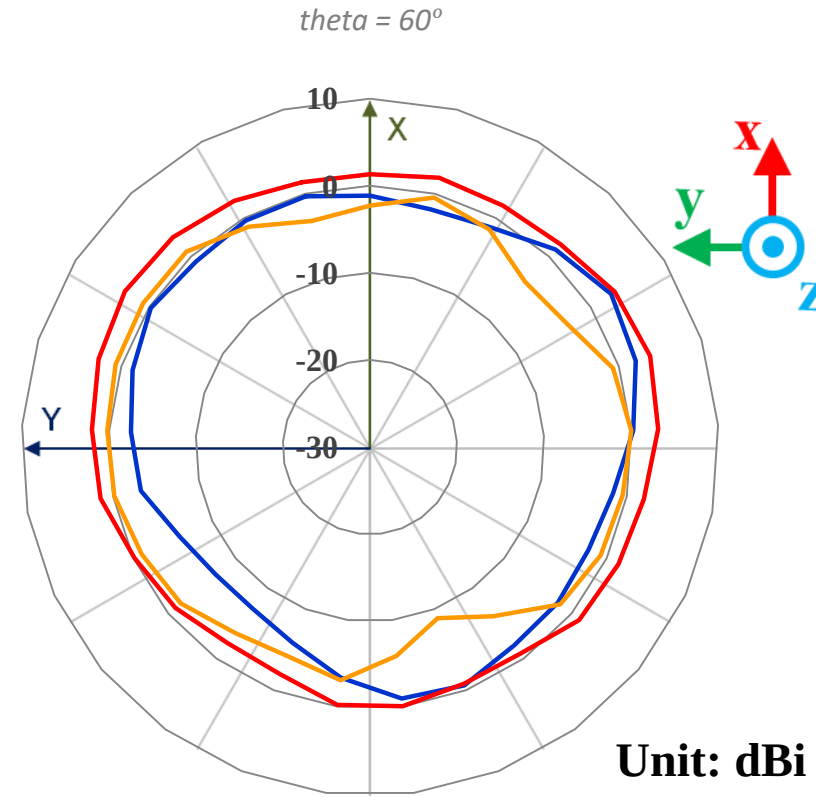
Realized Gain Pattern Scanning @5925MHz for G_{total}



— SC1 — SC2 — Composite



— SC1 — SC2 — Composite

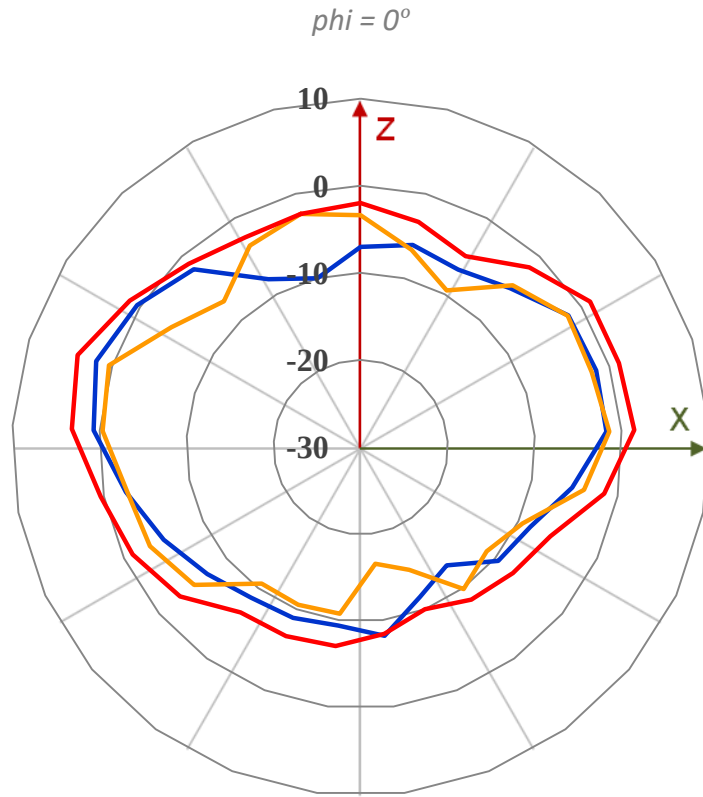


— SC1 — SC2 — Composite

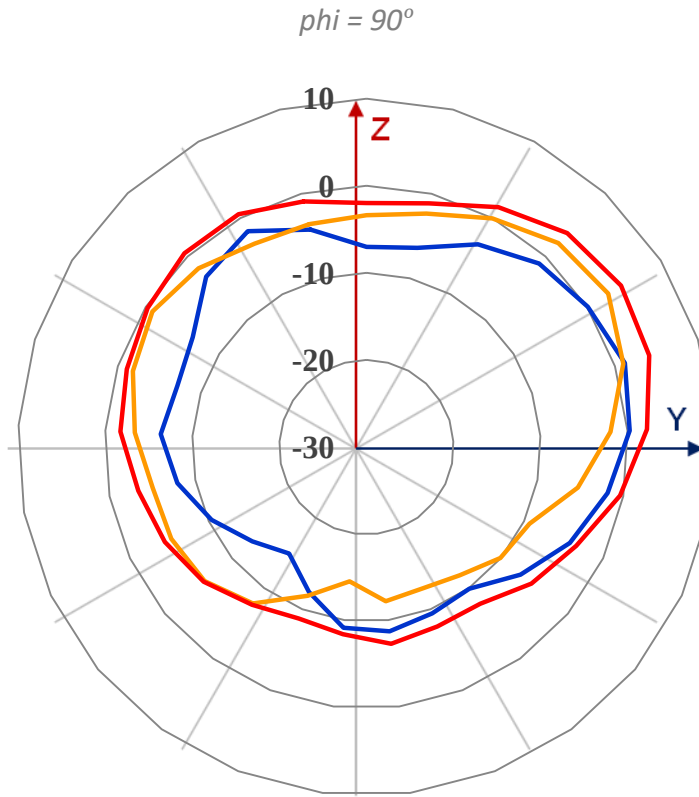
Unit: dBi



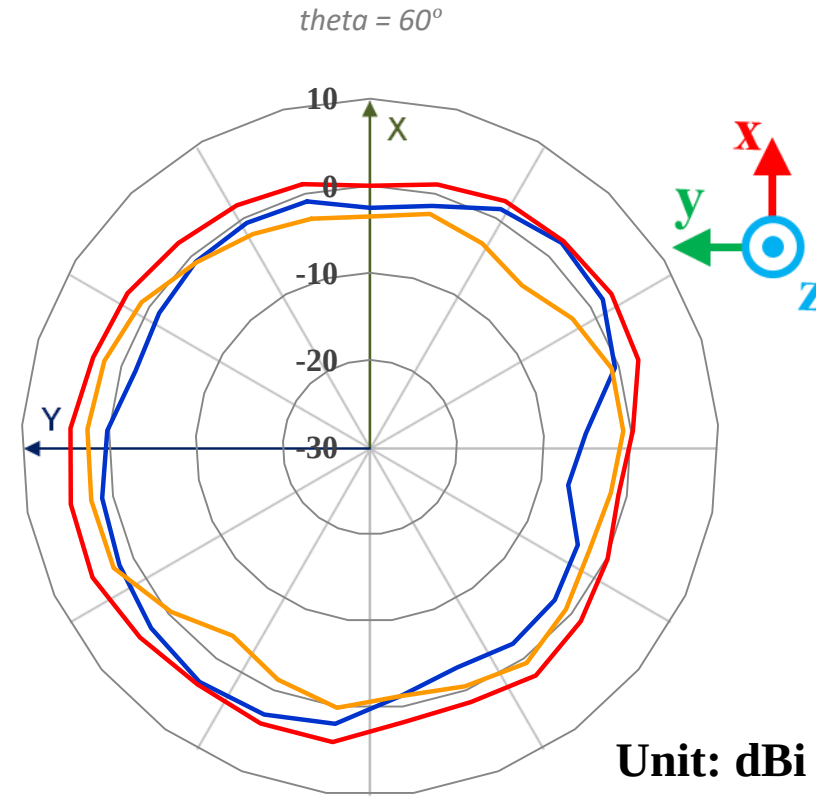
Realized Gain Pattern Scanning @6565MHz for G_{total}



— SC1 — SC2 — Composite



— SC1 — SC2 — Composite

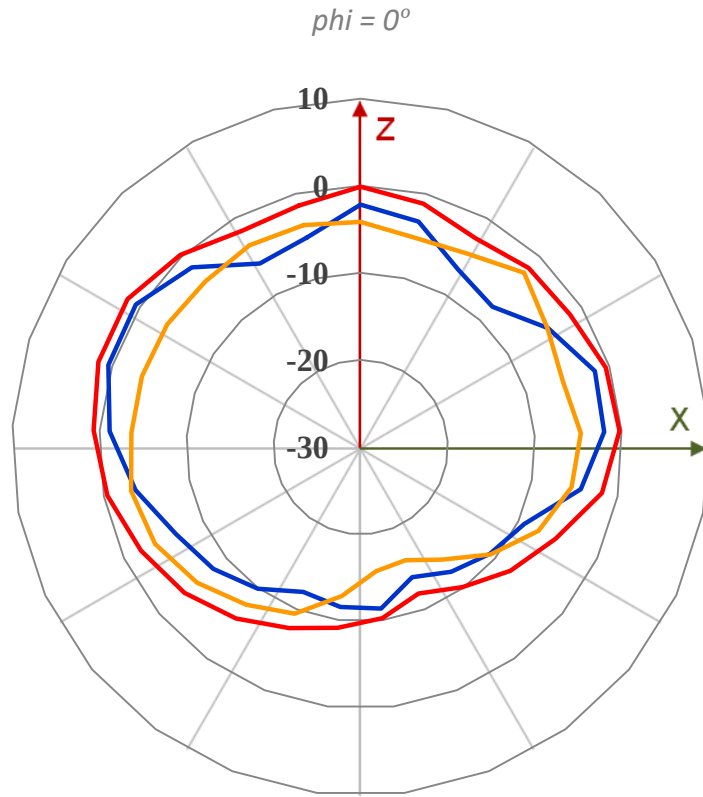


— SC1 — SC2 — Composite

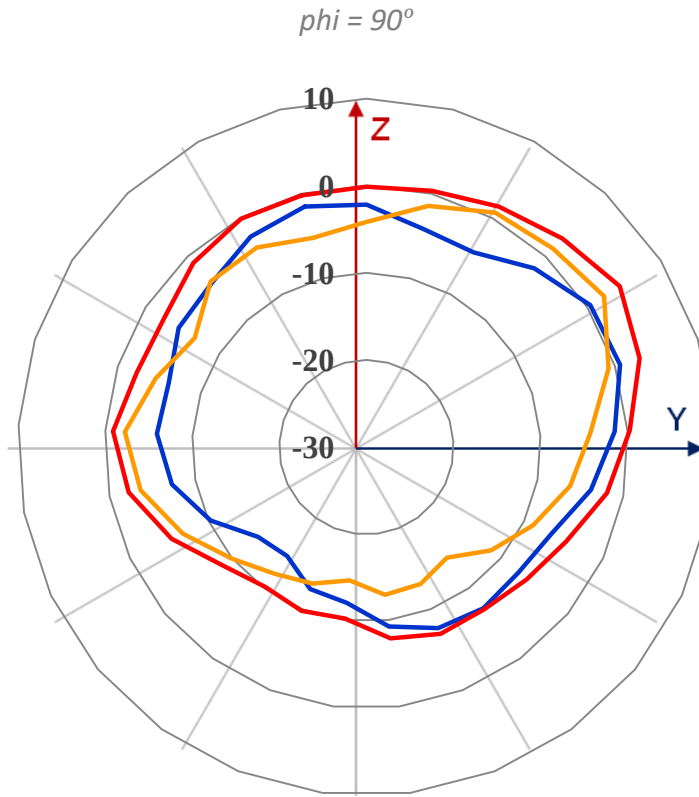
Unit: dBi



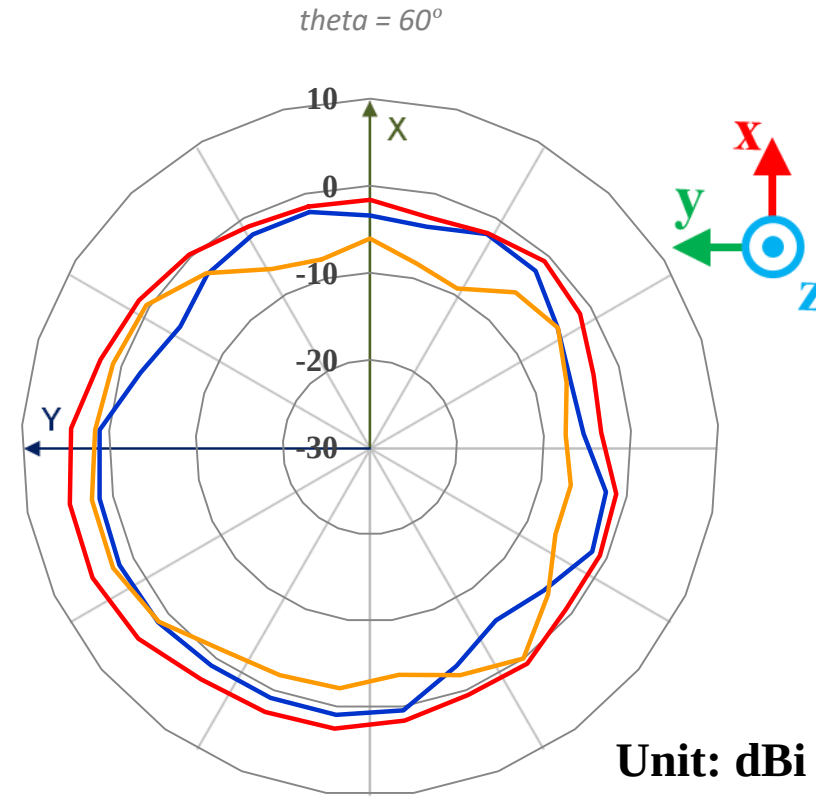
Realized Gain Pattern Scanning @7125MHz for G_{total}



— SC1 — SC2 — Composite



— SC1 — SC2 — Composite

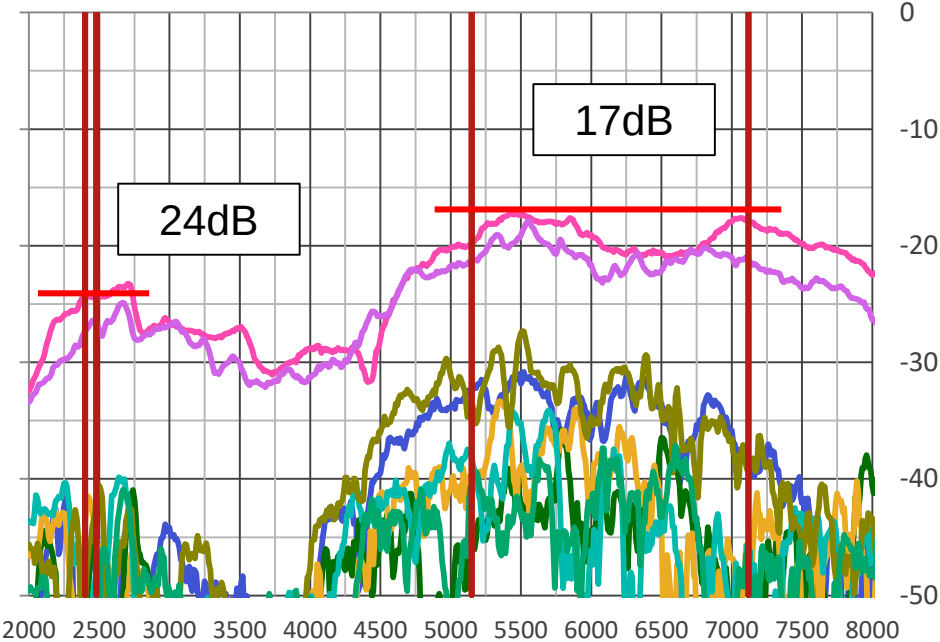


— SC1 — SC2 — Composite

Unit: dBi



Isolation Scanning to Single 6G



Frequency [MHz]

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

2.4GHz	Max	Mean	Min
SC1_6G1	-45.0	-48.1	-54.9
SC1_6G2	-45.1	-47.6	-51.8
SC1_6G3	-41.5	-43.1	-45.2
SC1_6G4	-24.3	-24.4	-24.5
SC2_6G1	-47.1	-53.9	-61.9
SC2_6G2	-26.4	-26.8	-27.4
SC2_6G3	-41.5	-45.4	-50.8
SC2_6G4	-51.7	-53.1	-55.6
Summary	-24.3	-42.8	-61.9

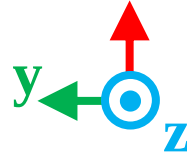
5_6GHz	Max	Mean	Min
SC1_6G1	-30.8	-34.1	-40.4
SC1_6G2	-35.8	-43.6	-66.5
SC1_6G3	-33.3	-41.9	-68.4
SC1_6G4	-17.2	-19.1	-21.0
SC2_6G1	-34.1	-44.8	-65.4
SC2_6G2	-17.9	-20.8	-23.2
SC2_6G3	-27.3	-33.4	-41.6
SC2_6G4	-37.1	-44.3	-70.4
Summary	-17.2	-35.3	-70.4



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]

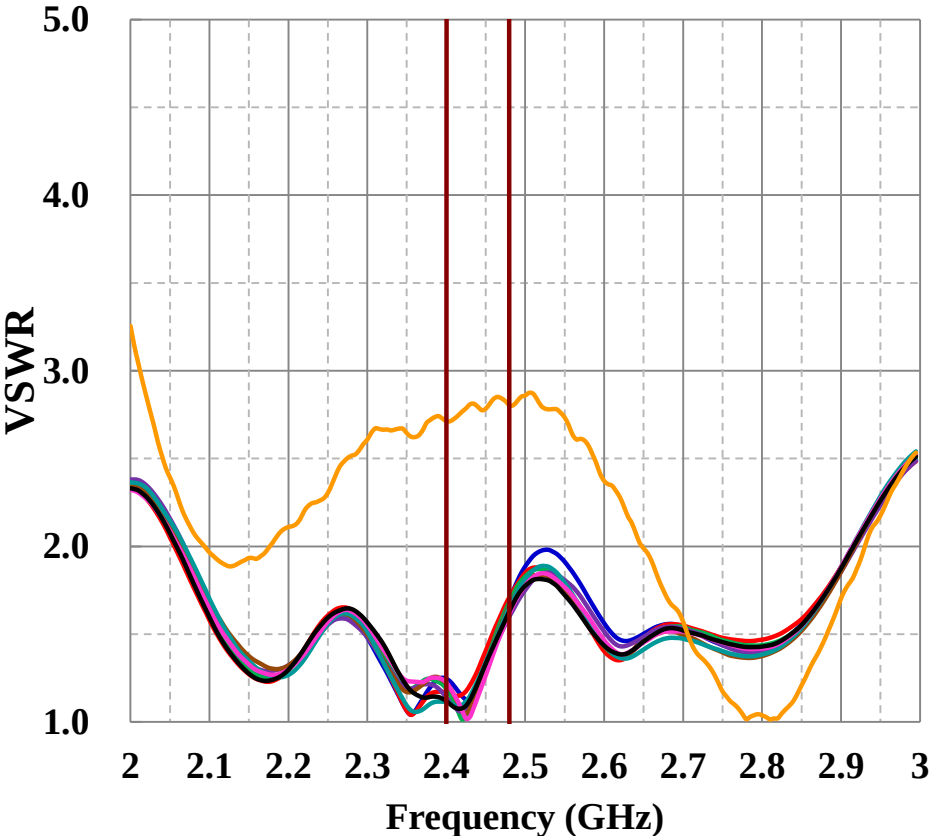
■ Beam Width

- ~40.8° on 2.4GHz [Beam1~Beam8]

X



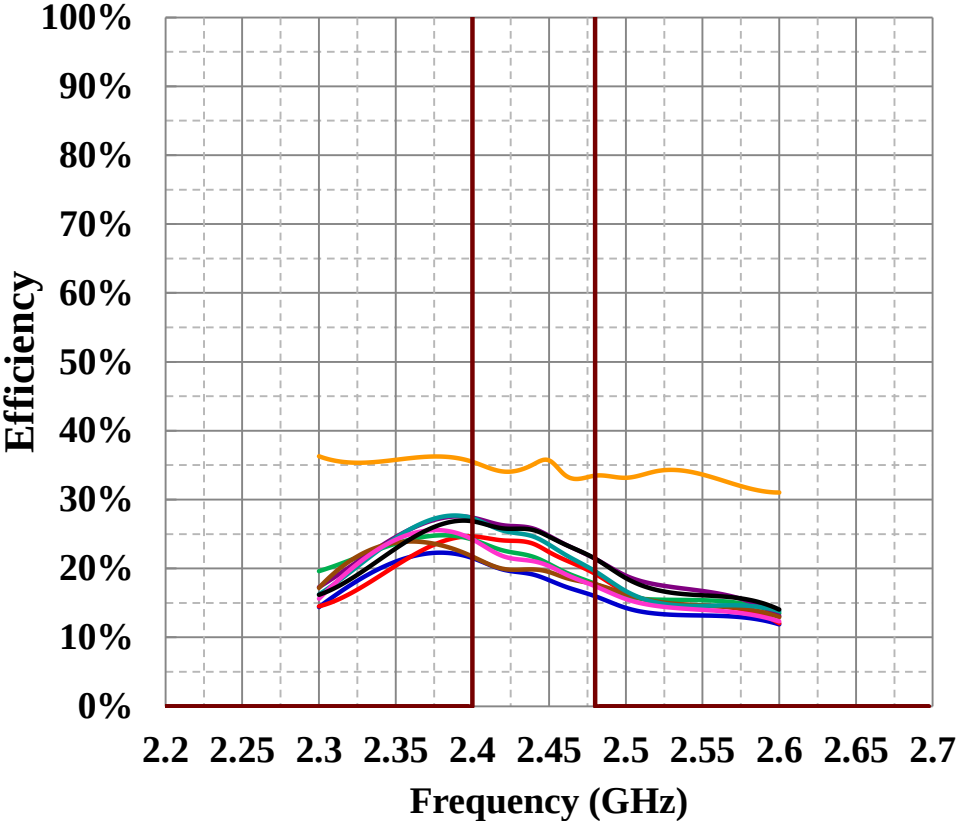
VSWR Directional Beam – P2A Sample



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

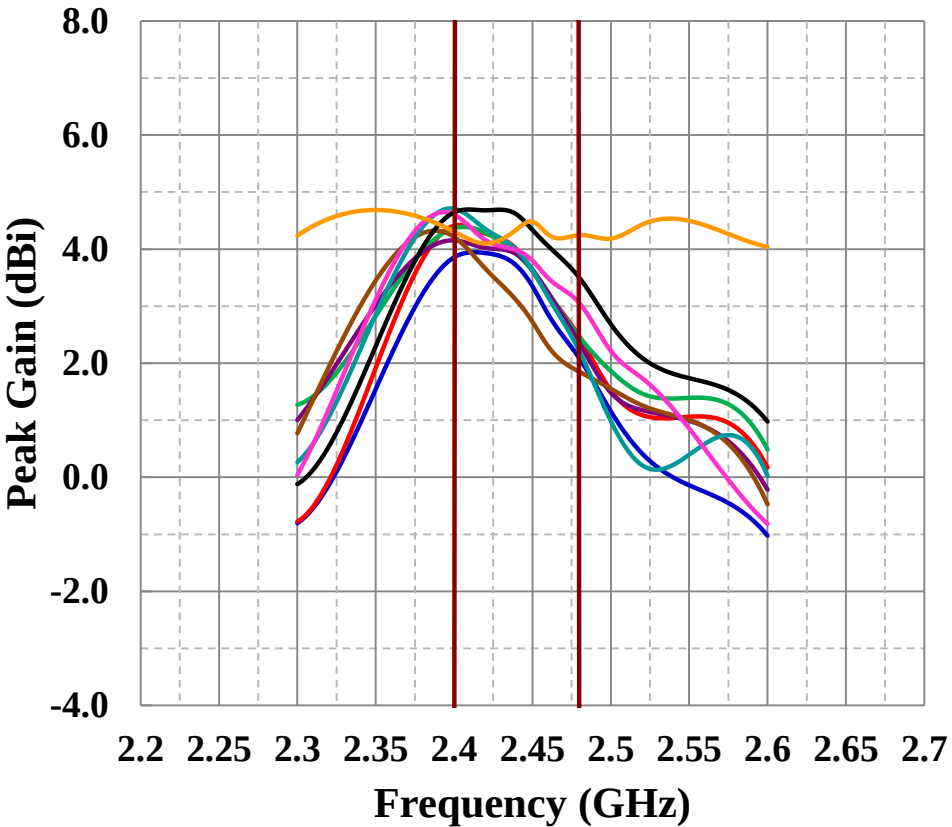


2.4GHz	Max	Mean	Min
Beam 1	21.5%	18.9%	16.2%
Beam 2	24.7%	22.8%	19.5%
Beam 3	24.2%	21.3%	18.0%
Beam 4	27.4%	25.1%	21.7%
Beam 5	21.7%	19.6%	17.8%
Beam 6	27.3%	24.0%	19.9%
Beam 7	24.2%	20.8%	17.7%
Beam 8	26.9%	24.9%	21.7%
Beam 9	35.8%	34.4%	33.0%

Beam1 Beam2 Beam3 Beam4 Beam5
Beam6 Beam7 Beam8 Beam9



Peak Gain Directional Beam – P2A Sample

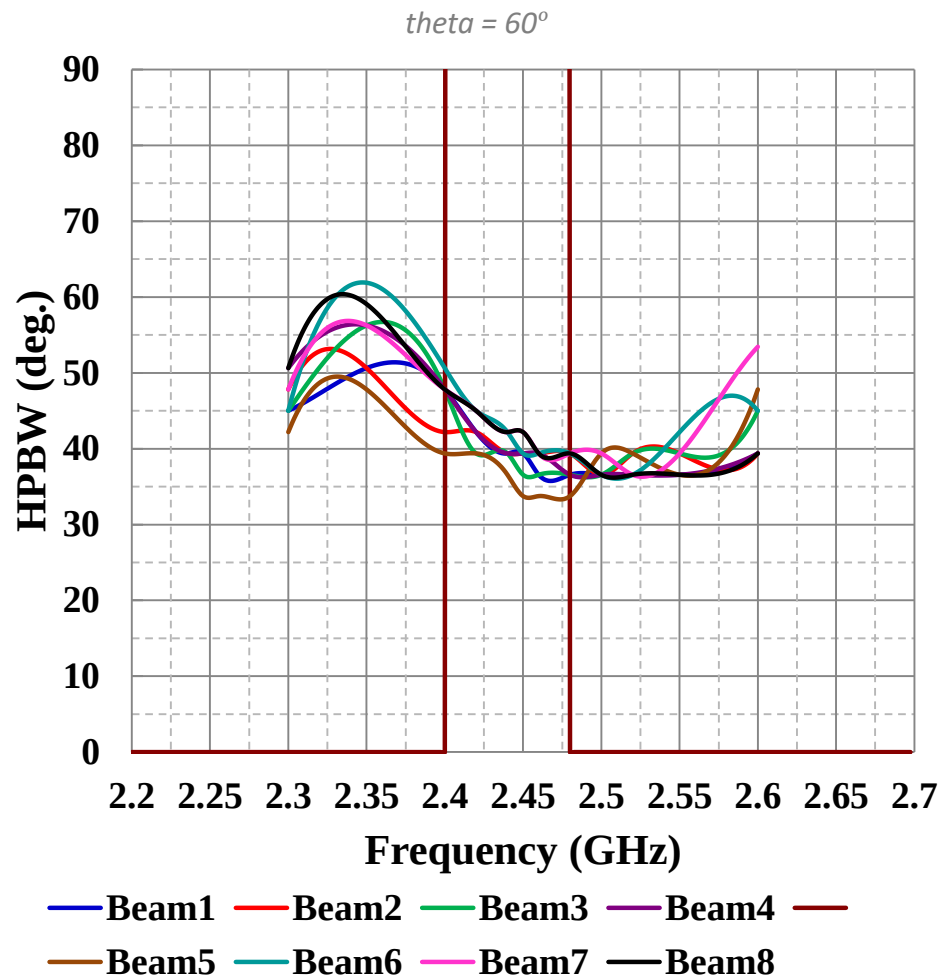


2.4GHz	Max	Mean	Min
Beam 1	3.9 dBi	3.4 dBi	2.2 dBi
Beam 2	4.4 dBi	3.8 dBi	2.6 dBi
Beam 3	4.4 dBi	3.8 dBi	2.5 dBi
Beam 4	4.2 dBi	3.7 dBi	2.5 dBi
Beam 5	4.2 dBi	3.1 dBi	1.9 dBi
Beam 6	4.7 dBi	3.8 dBi	2.3 dBi
Beam 7	4.6 dBi	3.9 dBi	3.1 dBi
Beam 8	4.7 dBi	4.4 dBi	3.6 dBi
Beam 9	4.5 dBi	4.2 dBi	4.1 dBi

Beam1 Beam2 Beam3 Beam4 Beam5
Beam6 Beam7 Beam8 Beam9



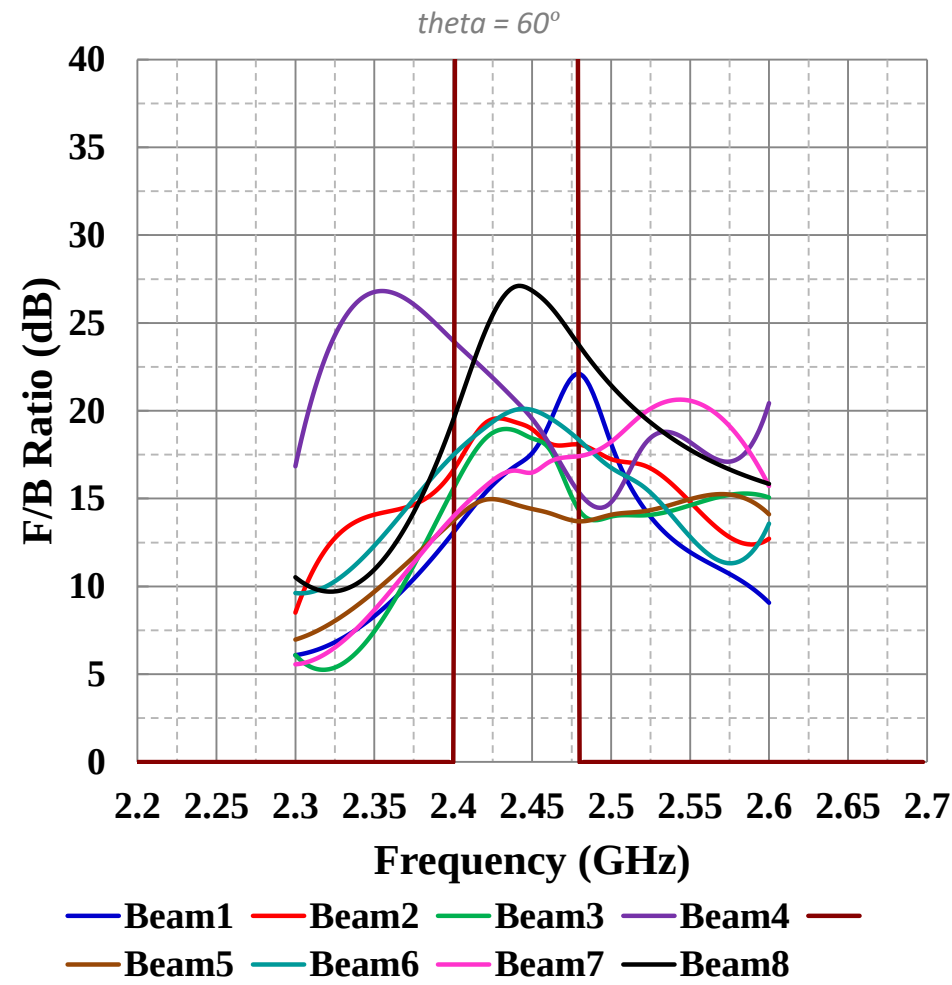
3dB Beam Width Directional Beam – P2A Sample



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°



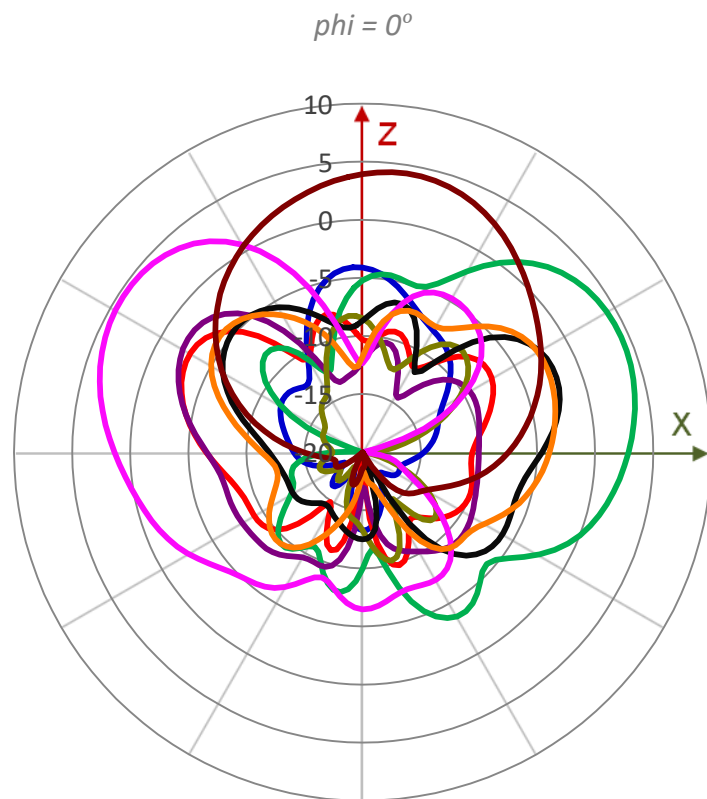
Front to Back Ratio Directional Beam – P2A Sample



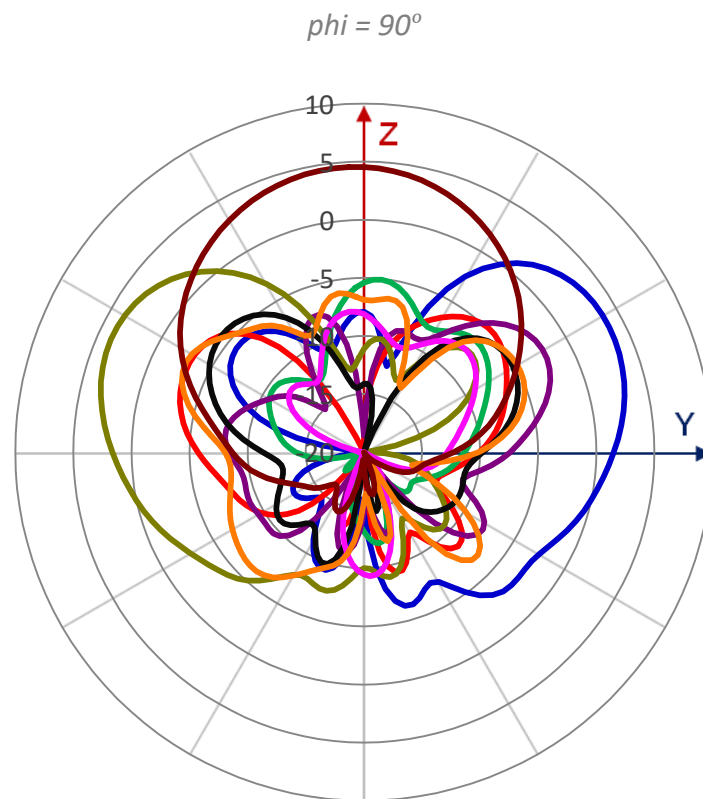
2.4GHz	Max	Mean	Min
Beam 1	22.1dB	17.1dB	13.1dB
Beam 2	19.6dB	18.6dB	16.6dB
Beam 3	19.0dB	17.6dB	14.7dB
Beam 4	24.0dB	20.3dB	15.6dB
Beam 5	15.0dB	14.4dB	13.7dB
Beam 6	20.1dB	19.2dB	17.5dB
Beam 7	17.4dB	16.2dB	14.0dB
Beam 8	27.1dB	24.9dB	19.5dB



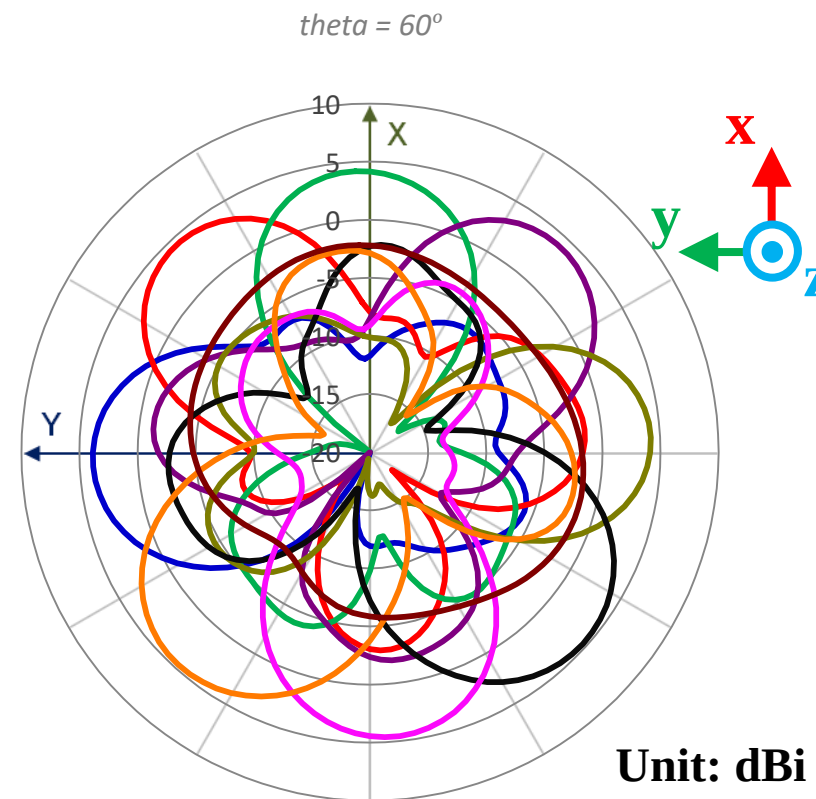
Realized Gain Pattern Directional Beam – P2A Sample @2400MHz for G_{total}



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



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

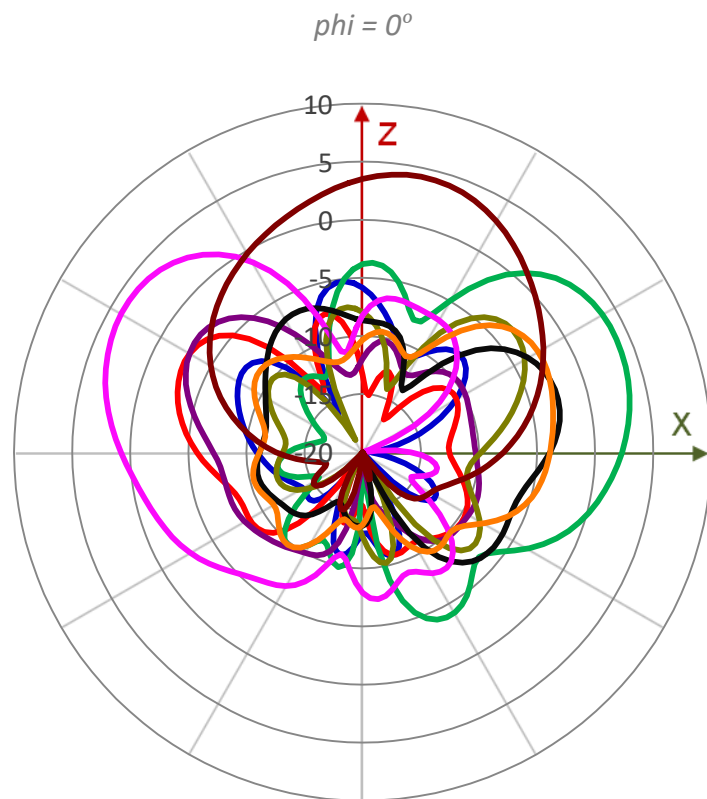


— Beam1 — Beam2 — Beam3
— Beam4 — Beam5 — Beam6
— Beam7 — Beam8 — Beam9

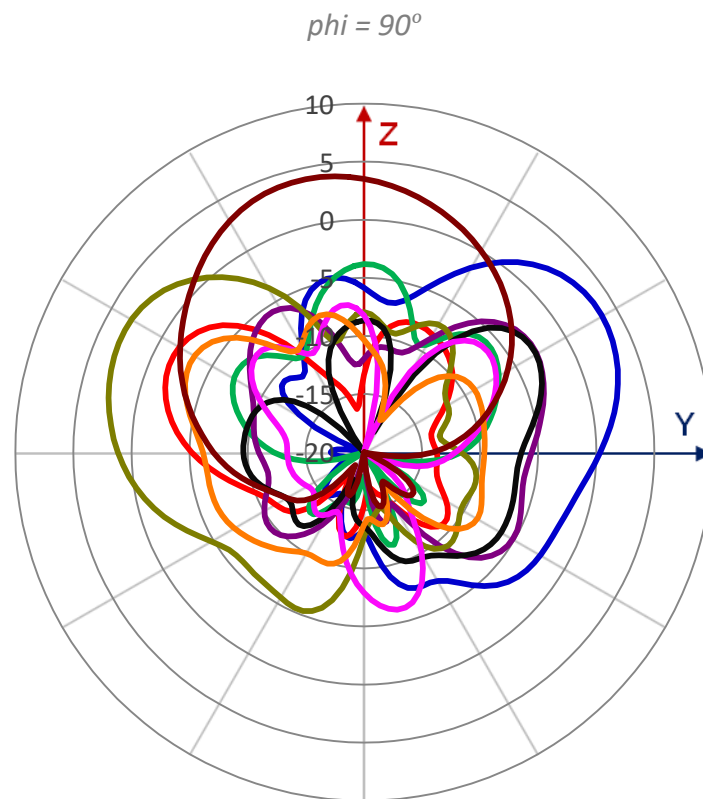
Unit: dBi



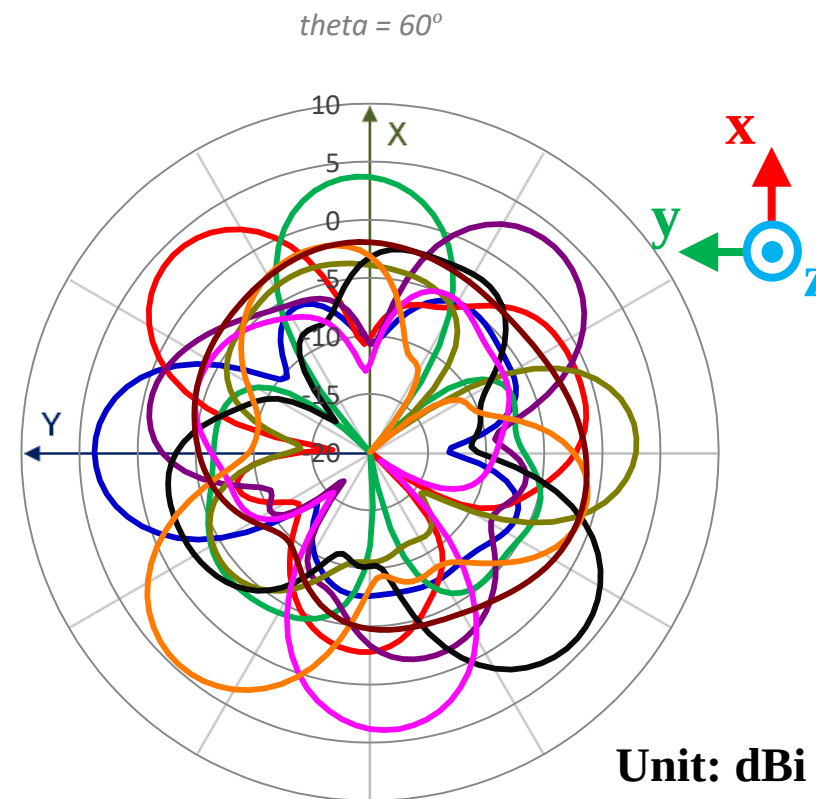
Realized Gain Pattern Directional Beam – P2A Sample @2440MHz for G_{total}



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



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

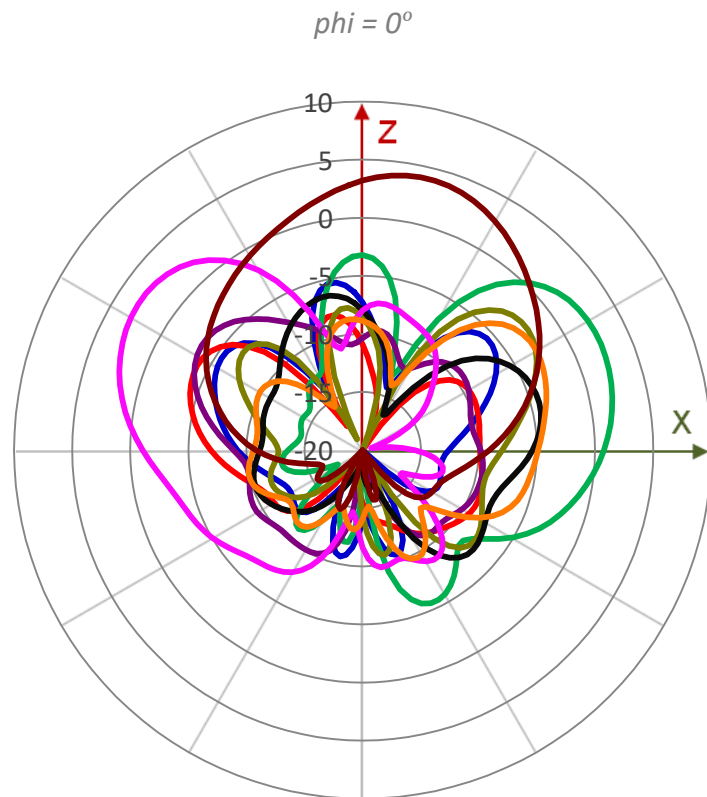


— Beam1 — Beam2 — Beam3
— Beam4 — Beam5 — Beam6
— Beam7 — Beam8 — Beam9

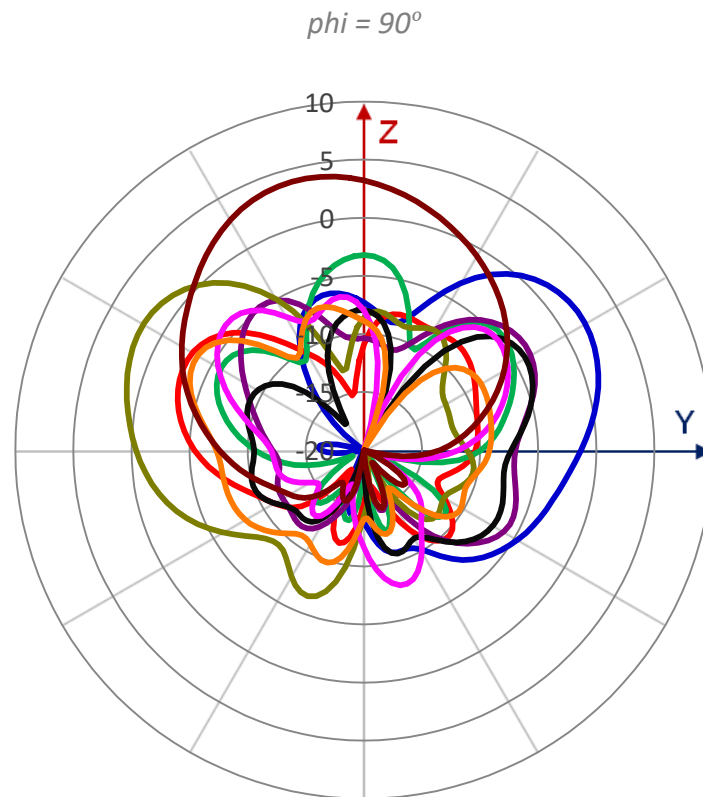
Unit: dBi



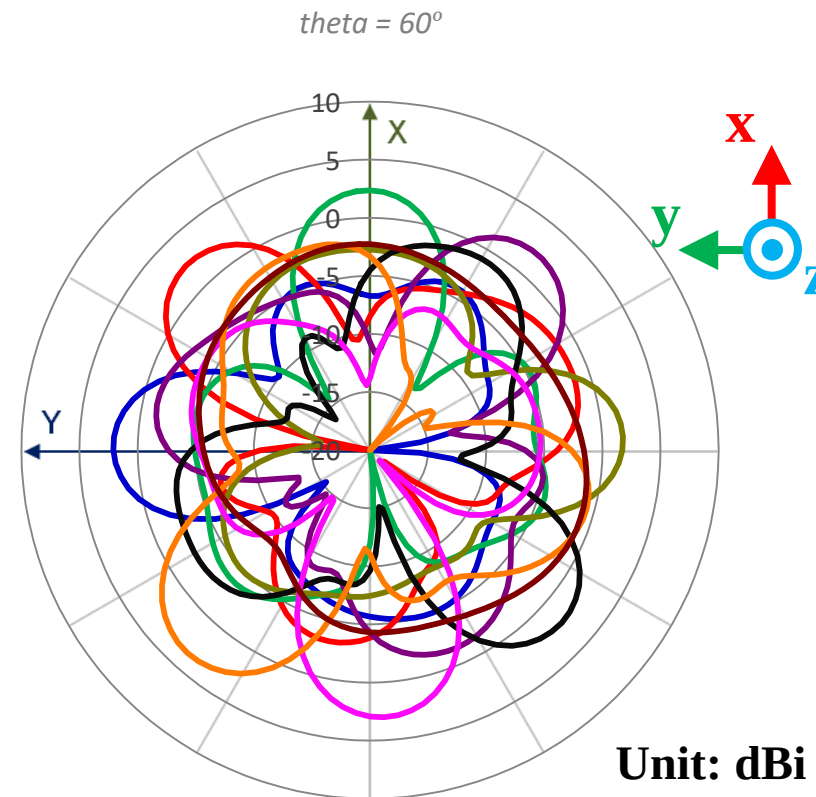
Realized Gain Pattern Directional Beam – P2A Sample @2480MHz for G_{total}



— 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

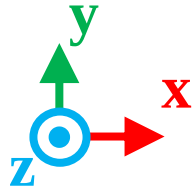
BLE Array – Omni Beam [P2A Sample]

- **Efficiency**

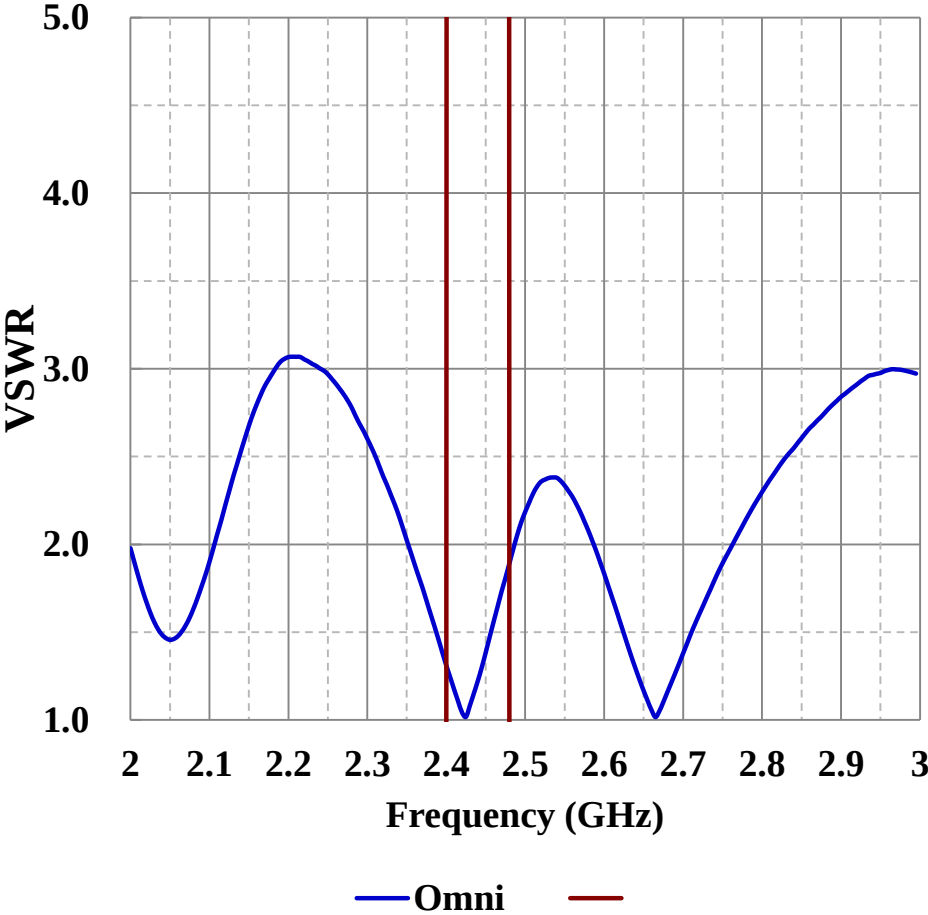
- ~28.4% on 2.4GHz

- **Peak Gain**

- 1.0dBi on 2.4GHz



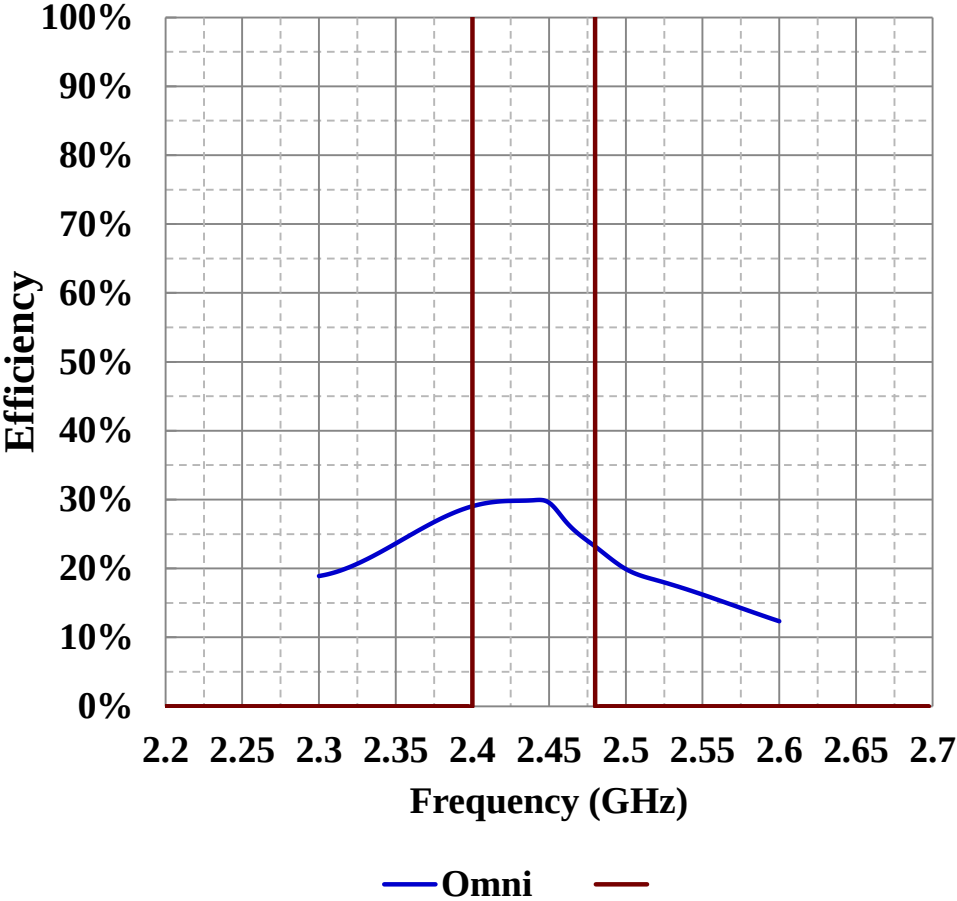
VSWR Omni Beam – P2A Sample



2.4GHz	Max	Mean	Min
Omni	1.89	1.36	1.02



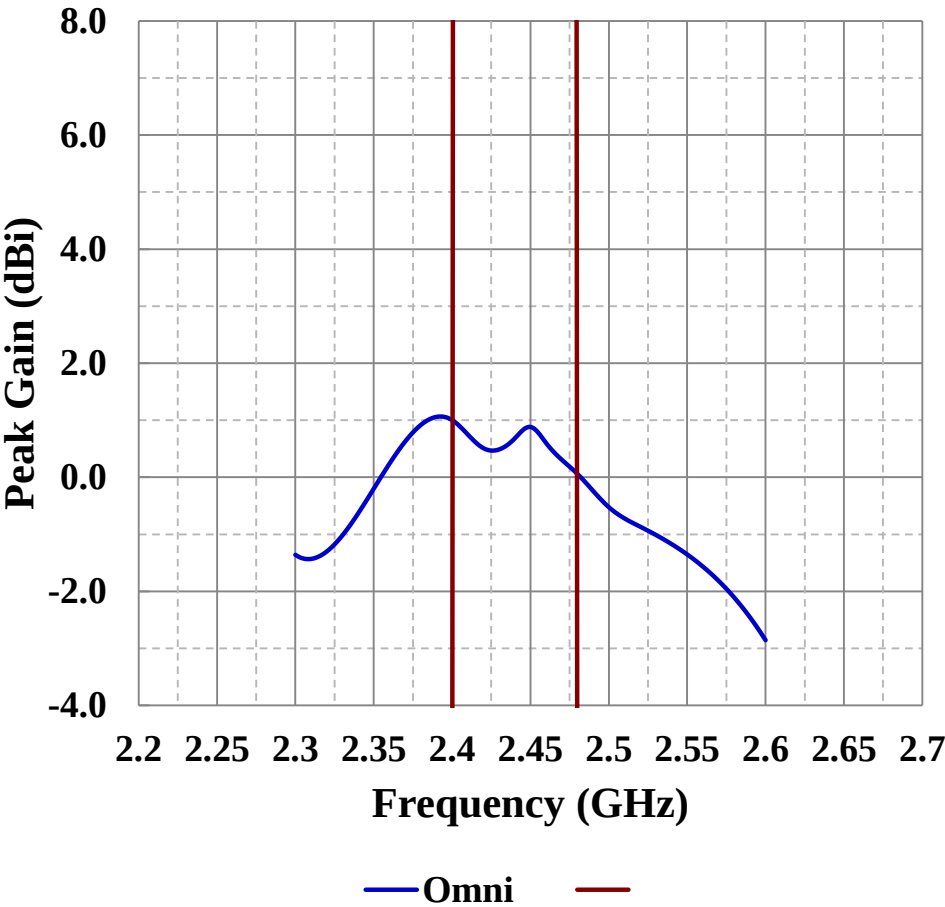
Efficiency Omni Beam – P2A Sample



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



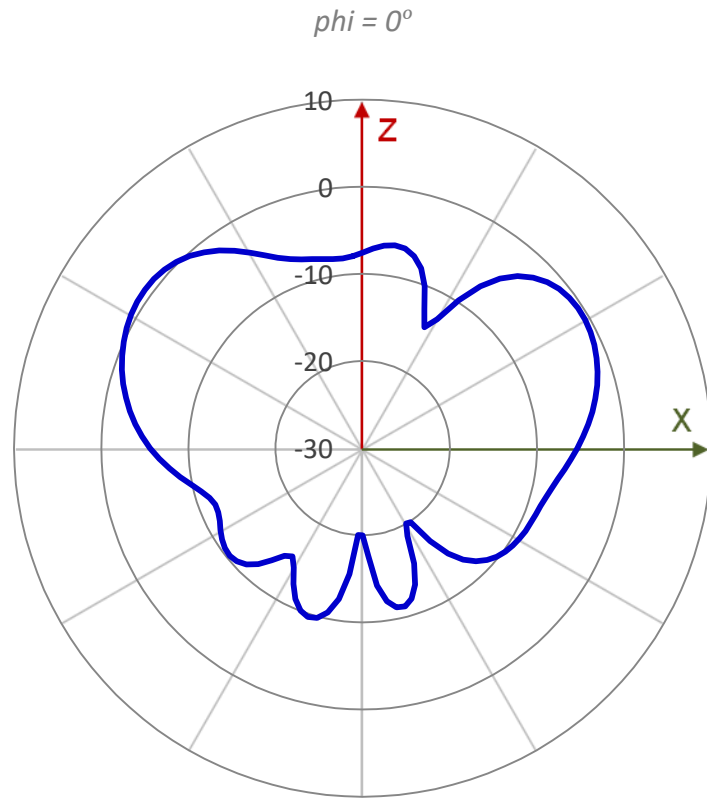
Peak Gain Omni Beam – P2A Sample



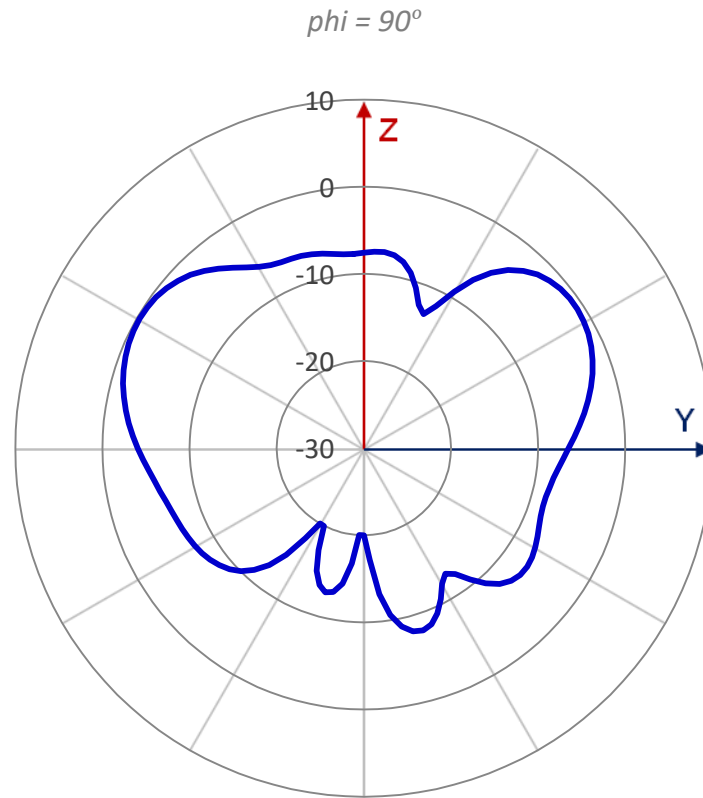
2.4GHz	Max	Mean	Min
Omni	1.0 dBi	0.6 dBi	0.1 dBi



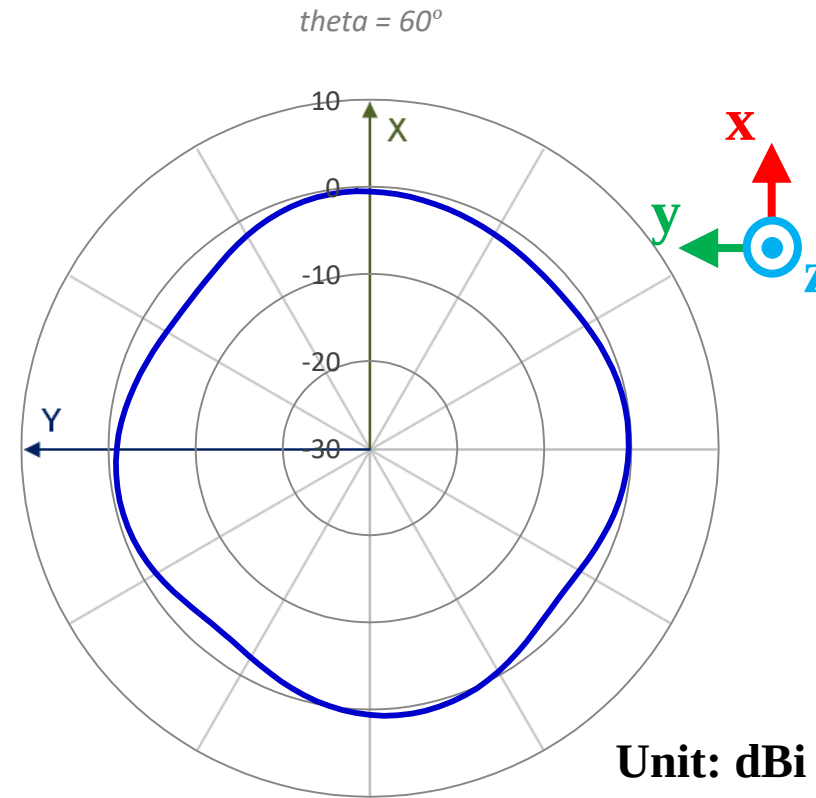
Realized Gain Pattern Omni Beam – P2A Sample @2400MHz for G_{total}



— Omni



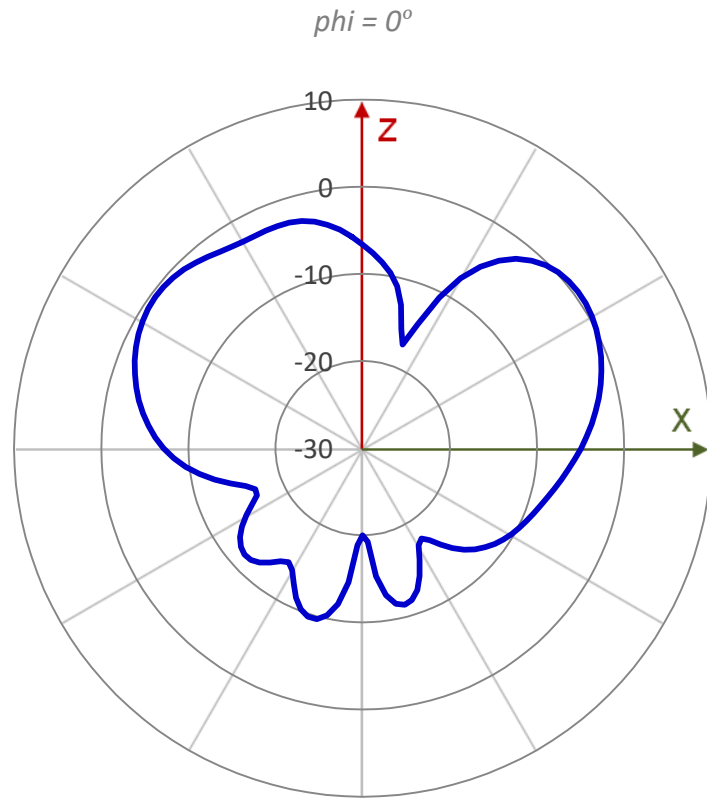
— Omni



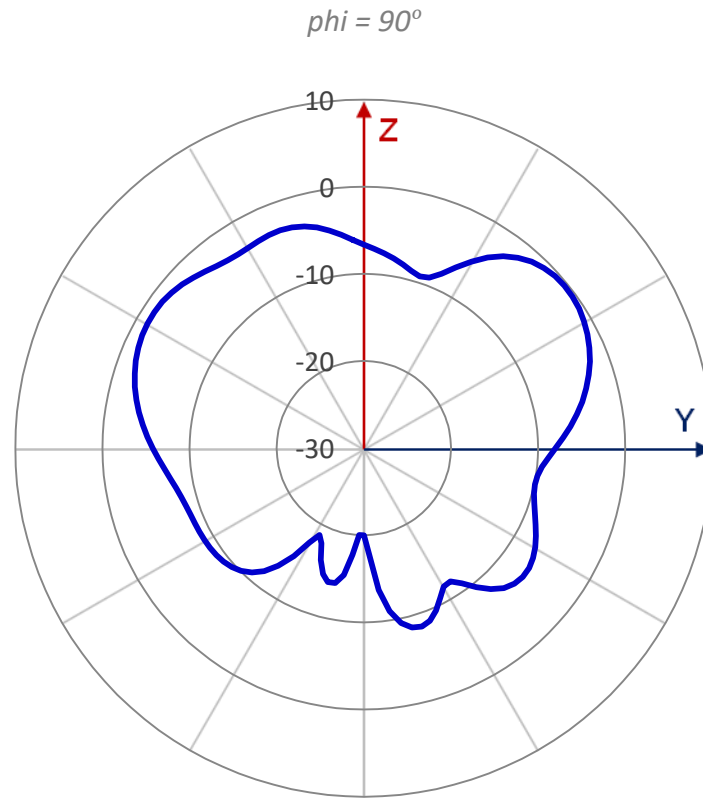
Unit: dBi



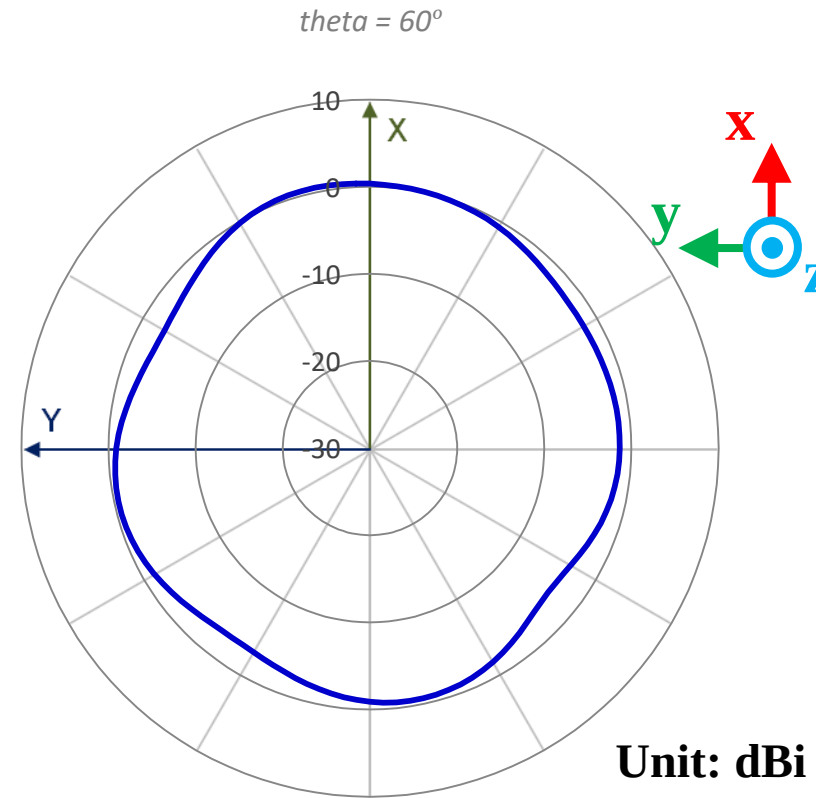
Realized Gain Pattern Omni Beam – P2A Sample @2440MHz for G_{total}



— Omni

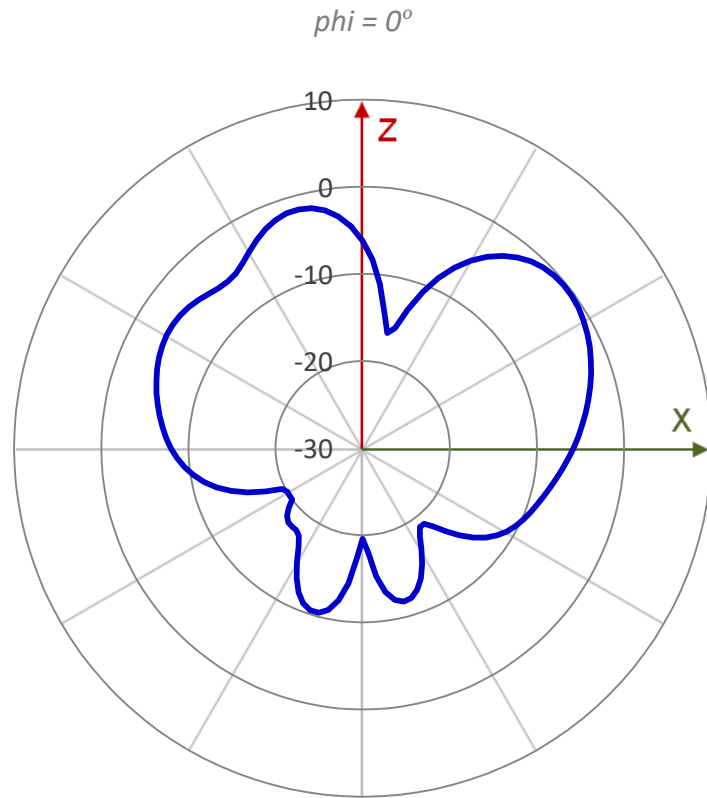


— Omni

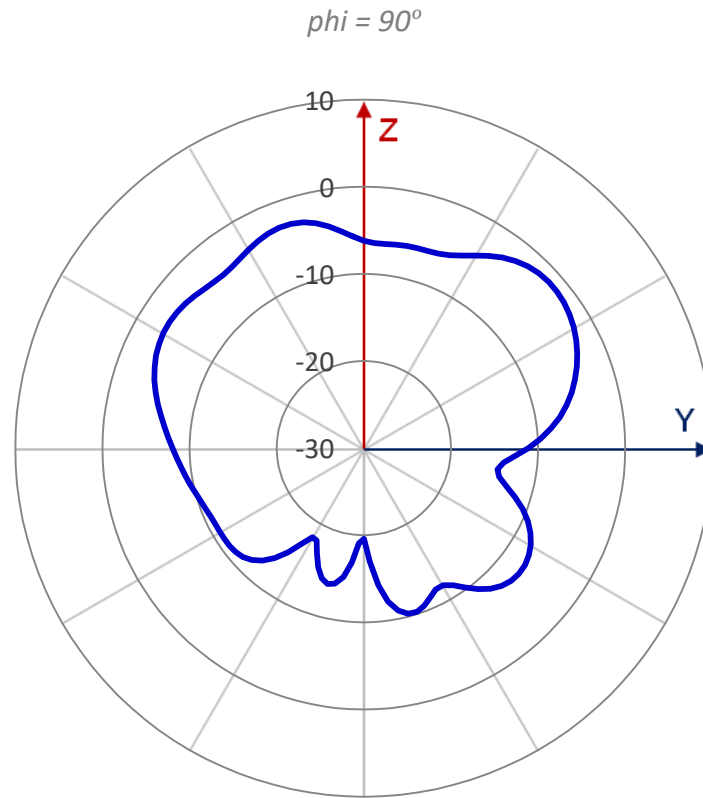


— Omni

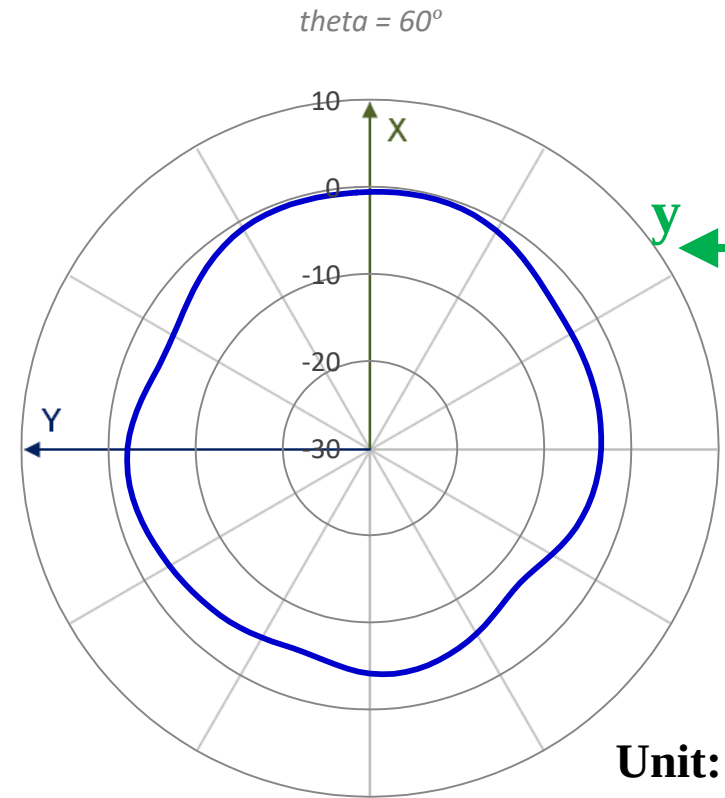
Realized Gain Pattern Omni Beam – P2A Sample @2480MHz for G_{total}



— Omni



— Omni



— Omni

Unit: dBi

