GALTRONICS

WHEN CONNECTIONS COUNT

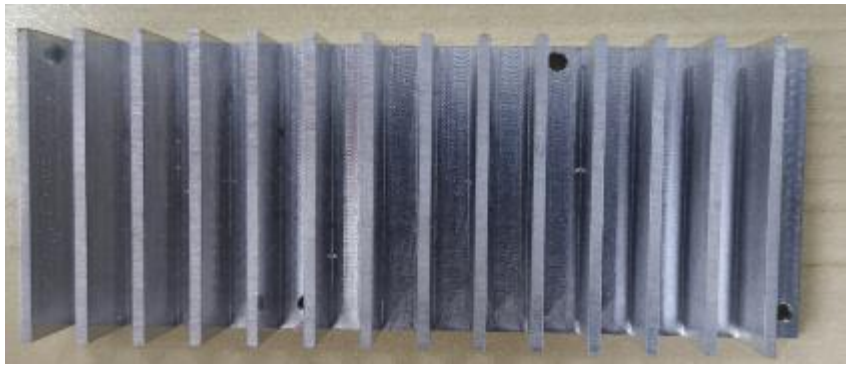
CIG WF-710G WiFi
Antenna Performance Report

Galtronics Project: 7996

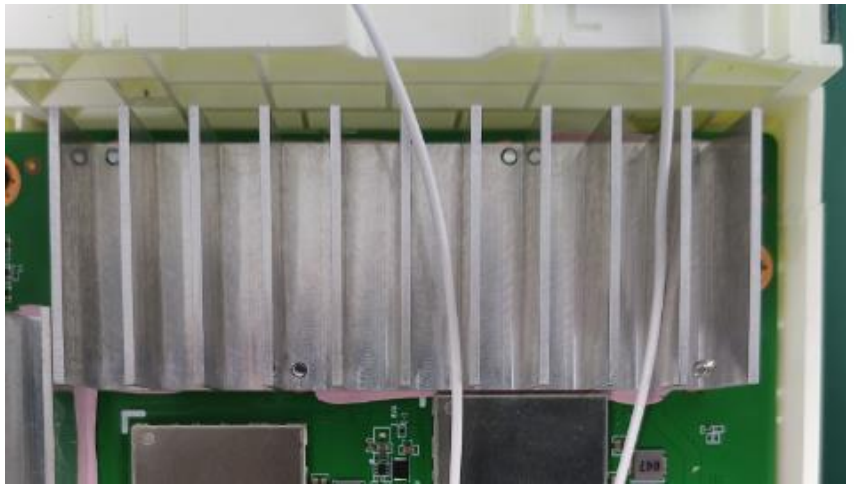
Prepared by Zack
Aug 3rd , 2023

Introduction

- Galtronics developed an antenna solution for CIG WF-710G
- There are 11 antennas :
  - Two Cabled PCB WIFI 2.4GHz antennas:- 2G0 and 2G1.
  - Four Cabled PCB WIFI 5GHz antennas :- 5G0,5G1,5G2 and 5G3.
  - Four Cabled PCB WIFI 6GHz antennas :- 6G0,6G1,6G2 and 6G3.
  - One on board BLE antennas:- BT.
- The operating frequency of 2.4GHz is 2.4 GHz-2.484GHz.
- The operating frequency of 5GHz is 5.17GHz-5.835GHz.
- The operating frequency of 6GHz is 5.945GHz-7.125GHz.
- The operating frequency of BLE is 2.4 GHz-2.5 GHz.
- Measured return loss, isolation, peak gain, efficiency, Correlated gain,UnCorrelated gain and gain patterns of the antennas

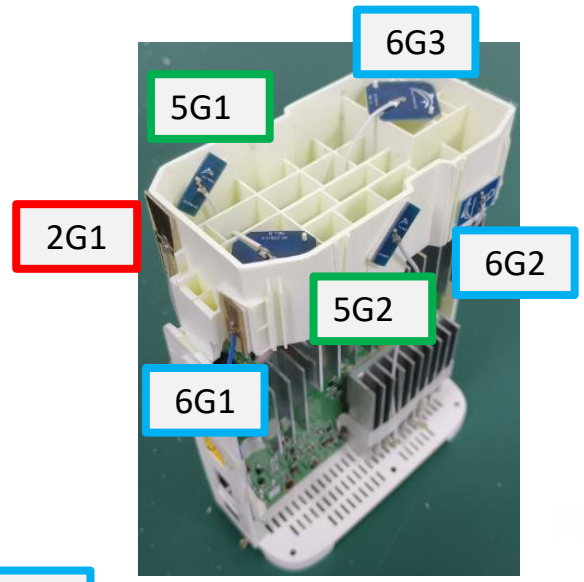


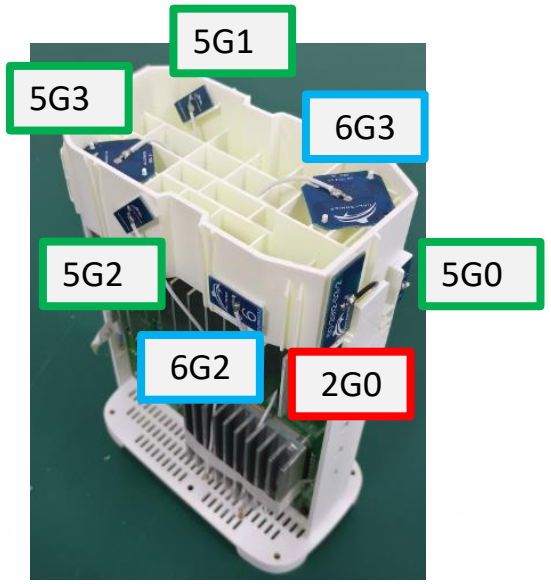
Original

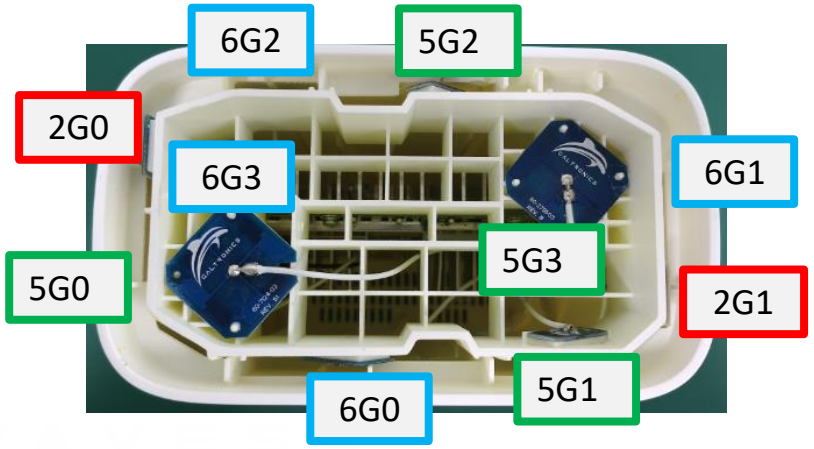


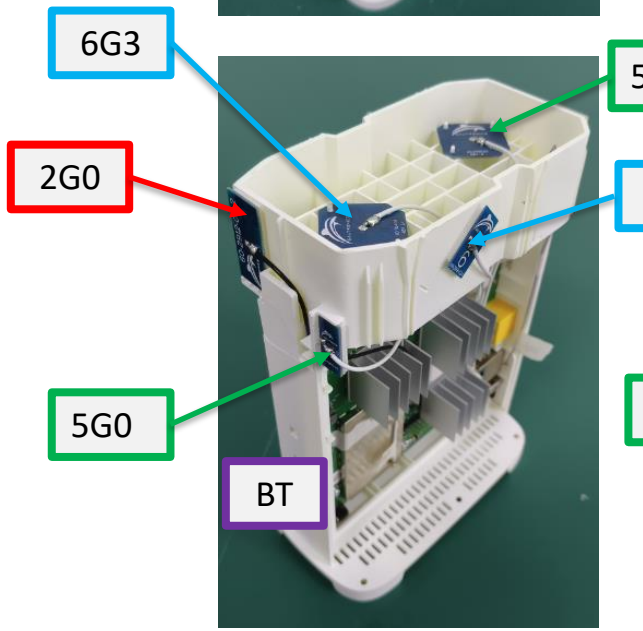
New

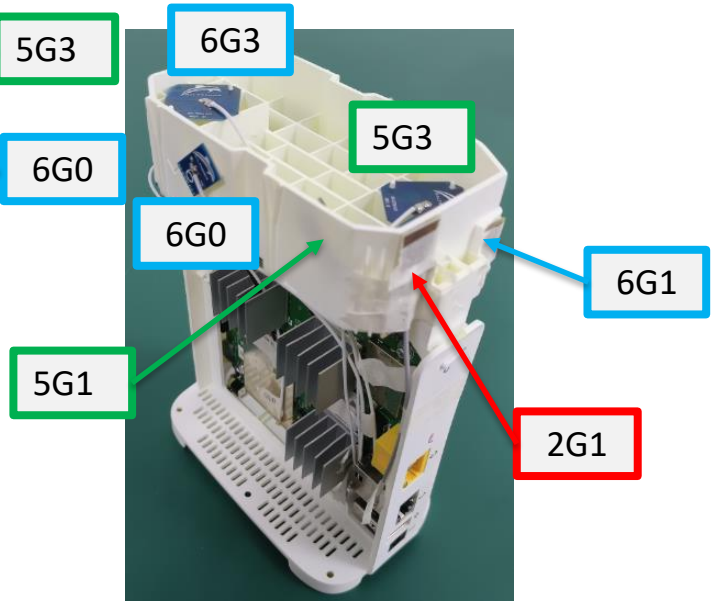
Antenna Location



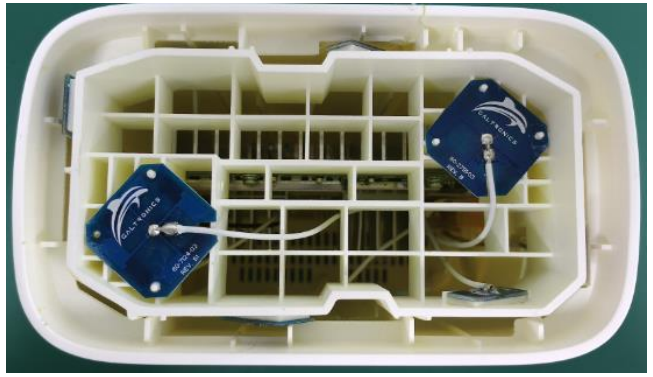


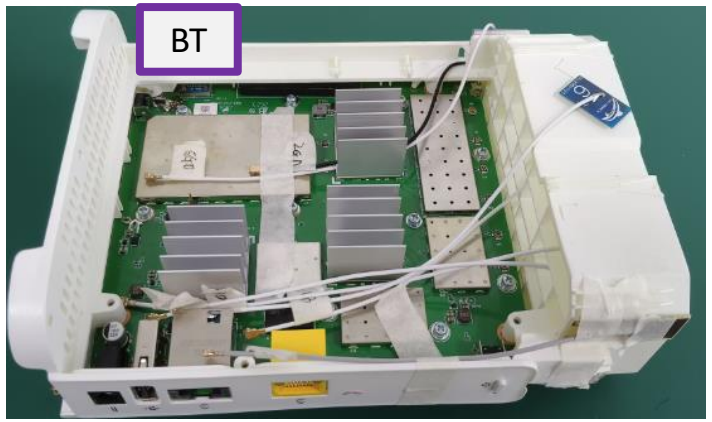




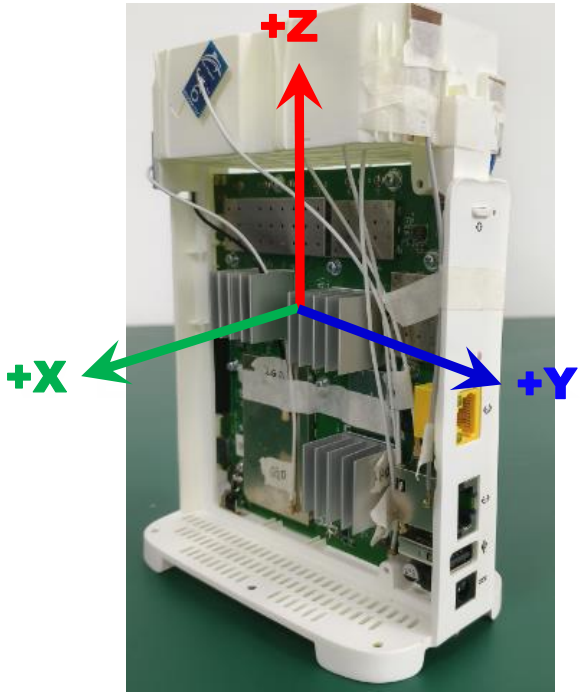


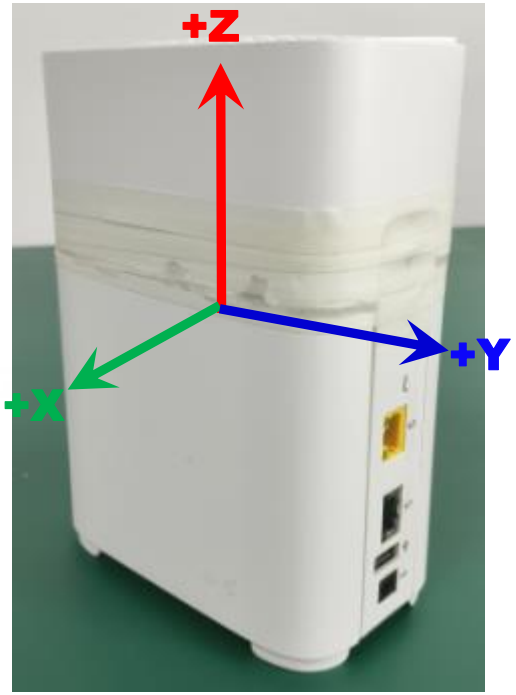
Antenna Environment



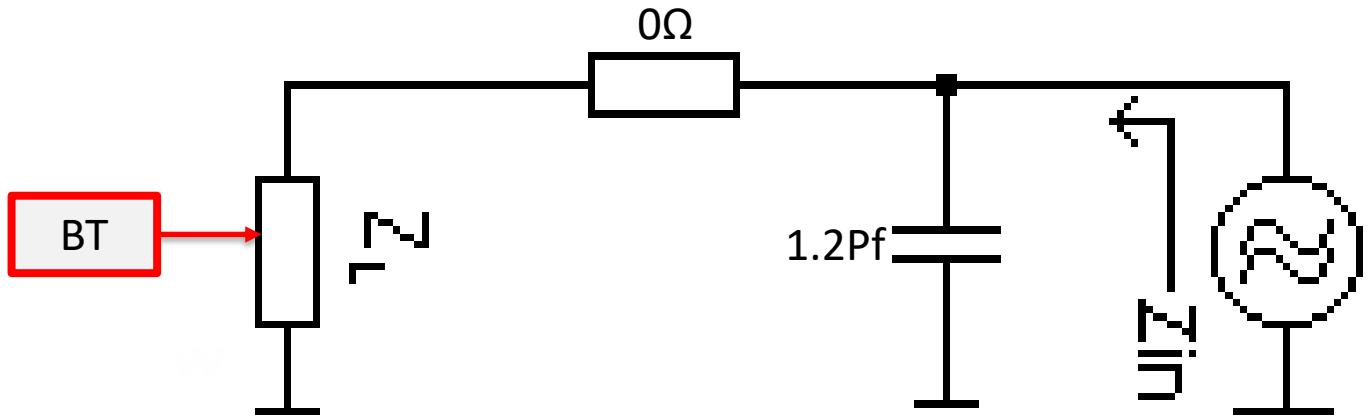


Chamber Coordinates





Matching Network for BT



Antenna Orientation

	Antenna Orientation
2G0	V
2G1	V
5G0	V
5G1	50°
5G2	45°
5G3	H-POL
6G0	45°
6G1	V
6G2	H
6G3	H-POL
BT	Mix

V = vertical
H = horizontal

WiFi Antenna Performance Summary

Antenna	Worst Return loss (dB)	Average Efficiency (%)	Highest Peak Gain（dB)	Mutual Isolation (dB) 2.4 GHz Band			Mutual Isolation (dB) 5GHz Band				Mutual Isolation (dB) 6GHz Band			
				2G0	2G1	BT	5G0	5G1	5G2	5G3	6G0	6G1	6G2	6G3
2G0	-12.2	70.73	3.99			-21.2	-24.2	-41.6	-36.5	-34.3	-29.0	-34.5	-28.8	-29.3
2G1	-14.4	66.36	3.88	-21.9		-27.4	-32.0	-21.2	-29.2	-31.2	-31.5	-15.7	-41.4	-42.4
BT	-13.5	54.30	2.36											
5G0	-16.4	70.82	4.61	-30.7	-35.2	-37.0					-29.6	-28.7	-39.2	-32.4
5G1	-13.5	70.53	4.76	-35.7	-31.7	-45.6	-28.0				-29.1	-32.4	-40.1	-34.0
5G2	-11.5	69.81	4.48	-31.7	-36.9	-39.6	-27.6	-28.5			-34.0	-27.8	-30.5	-32.0
5G3	-10.5	64.32	3.57	-39.0	-26.9	-34.4	-32.1	-24.2	-24.1		-33.4	-28.7	-32.4	-29.1
6G0	-12.2	70.94	4.81	-32.1	-43.3	-40.0	-27.4	-27.4	-31.4	-32.7				
6G1	-14.1	69.46	4.49	-27.2	-20.2	-30.4	-35.9	-28.5	-27.5	-26.6	-29.1			
6G2	-14.7	69.30	5.09	-29.4	-44.2	-38.1	-38.1	-35.7	-27.6	-36.1	-31.4	-36.3		
6G3	-10.4	63.39	3.70	-43.0	-45.5	-41.9	-35.1	-27.8	-30.7	-29.3	-23.1	-32.3	-24.4	

Gain & Efficiency summary

	Freq(MHz)	Peak Gain(dBi)	Directivity(dBi)	Efficiency(%)
2G0	2400	3.70	5.30	69.19
	2450	3.99	5.37	72.83
	2484	3.96	5.50	70.16
	Average			70.73

	Freq(MHz)	Peak Gain(dBi)	Directivity(dBi)	Efficiency(%)
2G1	2400	3.40	5.26	65.14
	2450	3.88	5.58	67.57
	2484	3.87	5.65	66.37
	Average			66.36

	Freq(MHz)	Peak Gain(dBi)	Directivity(dBi)	Efficiency(%)
BT	2400	2.10	4.98	51.61
	2450	2.32	5.06	53.21
	2500	2.36	4.72	58.09
	Average			54.30

Gain & Efficiency summary

	Freq(MHz)	Peak Gain(dBi)	Directivity(dBi)	Efficiency(%)
5G0	5170	4.40	6.10	67.58
	5350	4.61	6.07	71.46
	5550	4.38	6.01	68.64
	5750	4.49	5.79	74.11
	5835	4.59	6.00	72.30
	Average			70.82

	Freq(MHz)	Peak Gain(dBi)	Directivity(dBi)	Efficiency(%)
5G1	5170	4.76	6.18	72.19
	5350	4.40	5.91	70.64
	5550	4.15	5.78	68.66
	5750	4.15	5.86	67.45
	5835	4.66	5.99	73.69
	Average			70.53

	Freq(MHz)	Peak Gain(dBi)	Directivity(dBi)	Efficiency(%)
5G2	5170	4.28	5.77	70.95
	5350	4.48	5.96	71.08
	5550	4.18	5.80	68.77
	5750	4.40	6.04	68.48
	5835	4.38	5.94	69.76
	Average			69.81

	Freq(MHz)	Peak Gain(dBi)	Directivity(dBi)	Efficiency(%)
5G3	5170	3.43	5.21	66.42
	5350	3.21	5.21	63.02
	5550	3.17	5.18	62.98
	5750	3.57	5.50	64.12
	5835	3.56	5.43	65.07
	Average			64.32

Gain & Efficiency summary

	Freq(MHz)	Peak Gain(dBi)	Directivity(dBi)	Efficiency(%)
6G0	5945	4.36	5.95	69.19
	6300	4.78	6.07	74.29
	6500	4.48	5.97	70.85
	6800	4.81	6.35	70.14
	7125	4.71	6.24	70.22
	Average			70.94

	Freq(MHz)	Peak Gain(dBi)	Directivity(dBi)	Efficiency(%)
6G1	5945	4.49	6.42	64.05
	6300	4.42	5.83	72.29
	6500	4.10	5.50	72.37
	6800	4.37	5.95	69.59
	7125	4.32	5.93	68.99
	Average			69.46

	Freq(MHz)	Peak Gain(dBi)	Directivity(dBi)	Efficiency(%)
6G2	5945	4.55	6.31	66.71
	6300	5.08	6.47	72.61
	6500	4.68	6.40	67.39
	6800	5.01	6.62	68.96
	7125	5.09	6.59	70.82
	Average			69.30

	Freq(MHz)	Peak Gain(dBi)	Directivity(dBi)	Efficiency(%)
6G3	5945	3.55	5.61	62.17
	6300	3.23	5.18	63.89
	6500	3.70	5.38	67.92
	6800	3.06	5.23	60.60
	7125	3.32	5.37	62.39
	Average			63.39

Correlated/UnCorrelated Gain Calculation formula

$$\text{Correlated Gain} = 10\log\left[\left(10^{\frac{G1}{20}} + 10^{\frac{G2}{20}} + \cdots + 10^{\frac{Gn}{20}}\right)^2 / N_{Ant.}\right] dBi$$

$$\text{Uncorrelated Gain} = 10\log\left[\left(10^{\frac{G1}{10}} + 10^{\frac{G2}{10}} + \cdots + 10^{\frac{Gn}{10}}\right) / N_{Ant.}\right] dBi$$

$N_{Ant.}$: Number of antenna
G_n : Gain of antenna

Correlated Gain(2G)

	Degree		Gain(dBi)		Correlated Gain(dBi)-H Pol
Frequeccy(MHz)	Theta	Phi	2G0	2G1	
2400	45	135	-0.77	-6.48	-0.15
2450	45	138	-0.33	-6.41	0.16
2484	45	141	-0.01	-7.20	0.13

	Degree		Gain(dBi)		Correlated Gain(dBi)-V Pol
Frequeccy(MHz)	Theta	Phi	2G0	2G1	
2400	96	15	0.99	1.95	4.49
2450	93	15	1.50	2.30	4.92
2484	93	15	1.39	2.61	5.03

UnCorrelated Gain(2G)

	Degree		Gain(dBi)		UnCorrelated Gain(dBi)-H Pol
Frequeccy(MHz)	Theta	Phi	2G0	2G1	
2400	15	240	0.05	-12.07	-2.71
2450	45	138	-0.33	-6.41	-2.38
2484	45	144	0.03	-7.37	-2.25

	Degree		Gain(dBi)		UnCorrelated Gain(dBi)-V Pol
Frequeccy(MHz)	Theta	Phi	2G0	2G1	
2400	96	15	0.99	1.95	1.50
2450	96	15	1.35	2.42	1.92
2484	93	15	1.39	2.61	2.04

Correlated Gain(5G)

	Degree		Gain(dBi)				Correlated Gain(dBi)-H Pol
Frequeccy(MHz)	Theta	Phi	5G0	5G1	5G2	5G3	
5170	90	9	-25.23	-1.05	-0.30	1.61	3.84
5350	150	192	-8.14	0.89	2.91	-8.88	4.24
5550	150	192	-6.56	0.69	2.41	-10.54	4.00
5750	150	192	-8.62	1.05	2.87	-8.80	4.23
5835	150	186	-8.16	1.35	2.43	-7.23	4.40

	Degree		Gain(dBi)				Correlated Gain(dBi)-V Pol
Frequeccy(MHz)	Theta	Phi	5G0	5G1	5G2	5G3	
5170	105	45	3.34	4.10	-2.87	-13.34	6.03
5350	135	60	1.38	2.23	0.33	-9.13	5.69
5550	135	60	0.80	2.59	-0.47	-8.99	5.45
5750	135	63	1.29	2.39	-0.48	-8.85	5.54
5835	120	30	1.81	2.06	0.72	-12.22	5.64

UnCorrelated Gain(5G)

	Degree		Gain(dBi)				UnCorrelated Gain(dBi)-H Pol
Frequeccy(MHz)	Theta	Phi	5G0	5G1	5G2	5G3	
5170	90	9	-25.23	-1.05	-0.30	1.61	-1.01
5350	150	195	-7.84	0.81	2.97	-9.28	-0.62
5550	150	192	-6.56	0.69	2.41	-10.54	-0.94
5750	150	195	-8.39	0.98	2.93	-9.16	-0.60
5835	150	192	-7.40	0.92	2.87	-8.65	-0.59

	Degree		Gain(dBi)				UnCorrelated Gain(dBi)-V Pol
Frequeccy(MHz)	Theta	Phi	5G0	5G1	5G2	5G3	
5170	105	45	3.34	4.10	-2.87	-13.34	1.21
5350	105	45	3.37	3.67	-4.39	-12.23	0.90
5550	105	45	2.78	3.05	-6.39	-10.03	0.25
5750	120	66	2.75	-0.34	1.57	-24.01	0.26
5835	120	30	1.81	2.06	0.72	-12.22	0.37

Correlated Gain(6G)

	Degree		Gain(dBi)				Correlated Gain(dBi)-H Pol
Frequeccy(MHz)	Theta	Phi	6G0	6G1	6G2	6G3	
5945	150	183	0.26	-3.85	3.03	-1.28	5.92
6300	105	345	-6.12	-1.44	1.43	0.23	4.98
6500	138	180	-1.84	-10.28	2.45	1.23	5.09
6800	135	180	-2.33	-10.96	3.11	0.07	4.83
7125	150	0	0.40	-6.77	-1.77	0.16	4.45

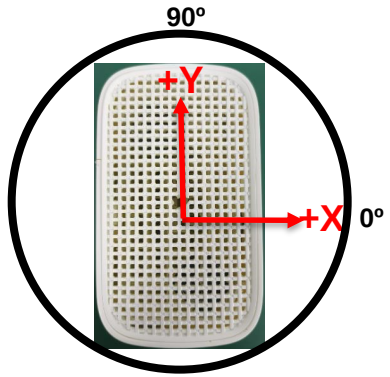
	Degree		Gain(dBi)				Correlated Gain(dBi)-V Pol
Frequeccy(MHz)	Theta	Phi	6G0	6G1	6G2	6G3	
5945	135	240	2.44	0.27	-0.69	-7.39	5.36
6300	108	285	1.08	3.91	-7.90	-6.78	5.01
6500	111	285	1.58	1.17	-6.30	-3.01	4.95
6800	105	285	0.97	2.91	-8.98	-4.55	4.77
7125	135	258	1.45	0.03	-2.57	-10.26	4.18

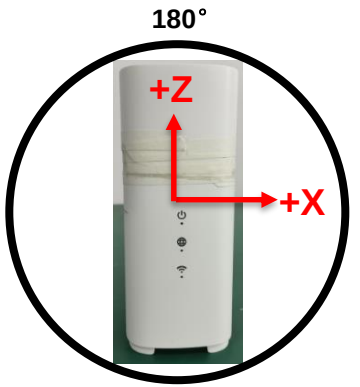
UnCorrelated Gain(6G)

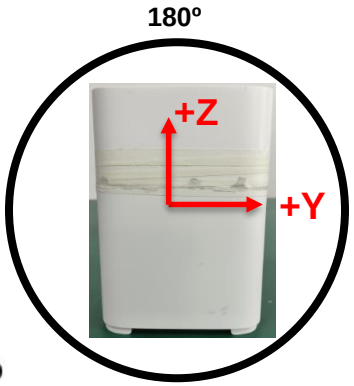
	Degree		Gain(dBi)				UnCorrelated Gain(dBi)-H Pol
Frequeccy(MHz)	Theta	Phi	6G0	6G1	6G2	6G3	
5945	150	189	-0.37	-4.05	3.52	-1.46	0.29
6300	147	183	0.15	-10.58	2.09	-0.59	-0.44
6500	138	180	-1.84	-10.28	2.45	1.23	-0.19
6800	138	180	-1.91	-11.75	3.10	-0.07	-0.30
7125	15	12	3.38	-6.04	-8.92	-0.49	-0.64

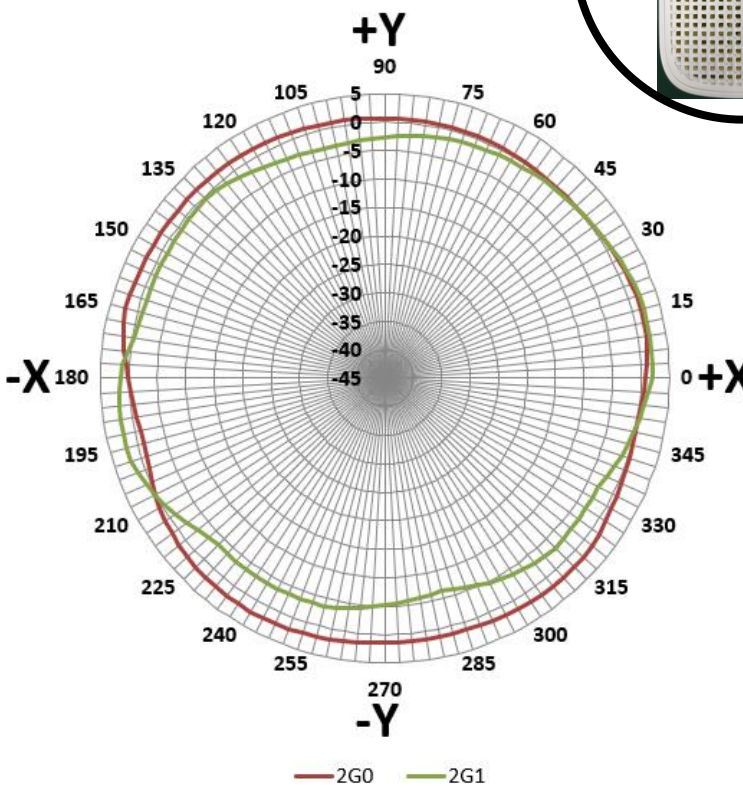
	Degree		Gain(dBi)				UnCorrelated Gain(dBi)-V Pol
Frequeccy(MHz)	Theta	Phi	6G0	6G1	6G2	6G3	
5945	135	243	2.49	0.20	-0.63	-7.72	-0.16
6300	105	285	0.87	4.29	-8.95	-7.75	0.21
6500	108	285	1.14	2.33	-7.24	-3.96	-0.46
6800	105	285	0.97	2.91	-8.98	-4.55	-0.36
7125	105	210	0.48	3.94	-13.40	-19.64	-0.40

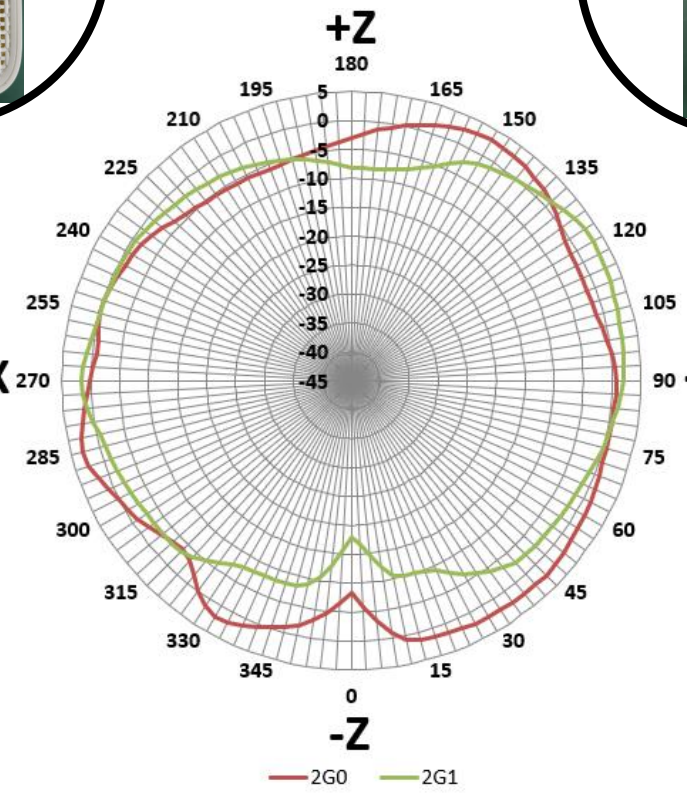
System Coverage- Gain [dB]
2450MHz

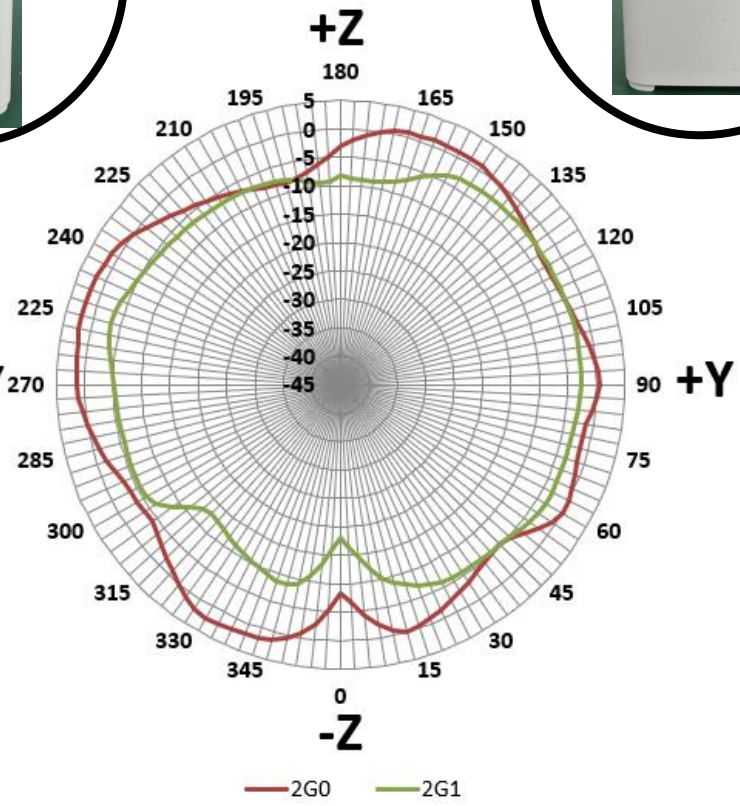




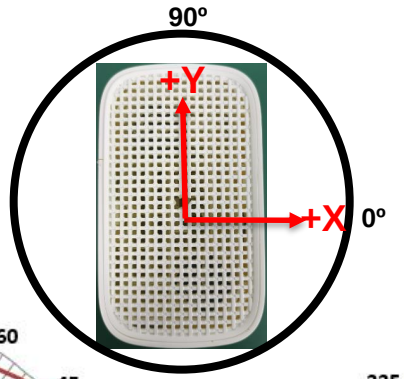


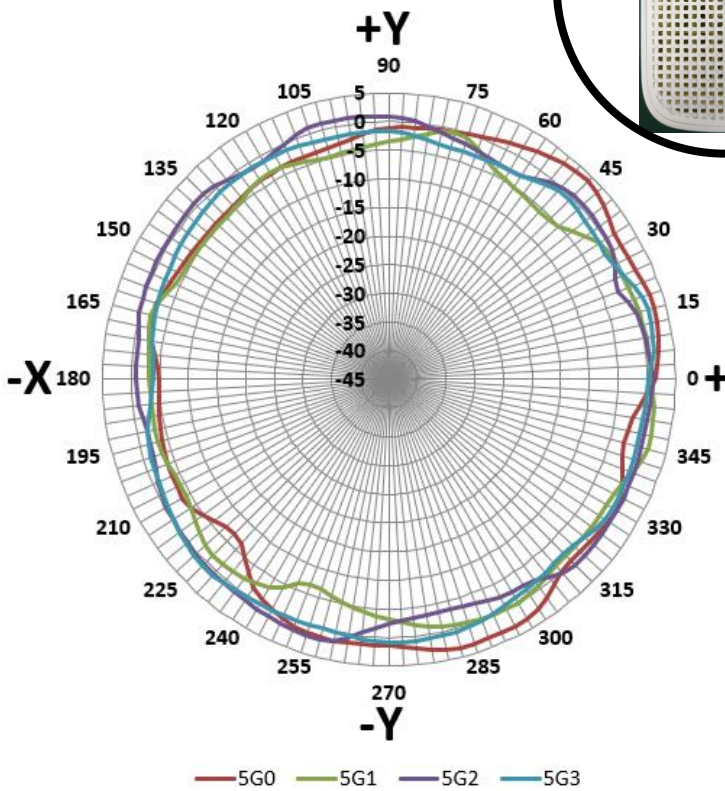


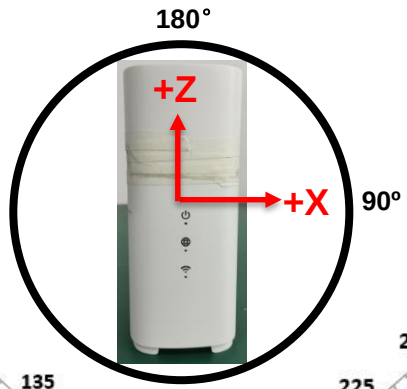


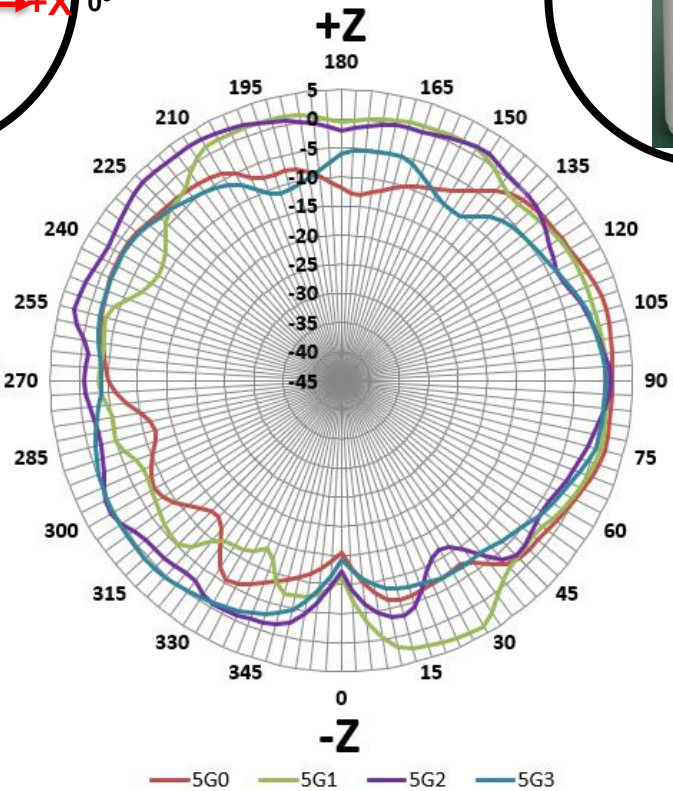


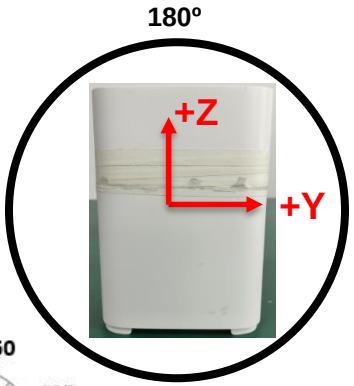
System Coverage- Gain [dB]
5350MHz

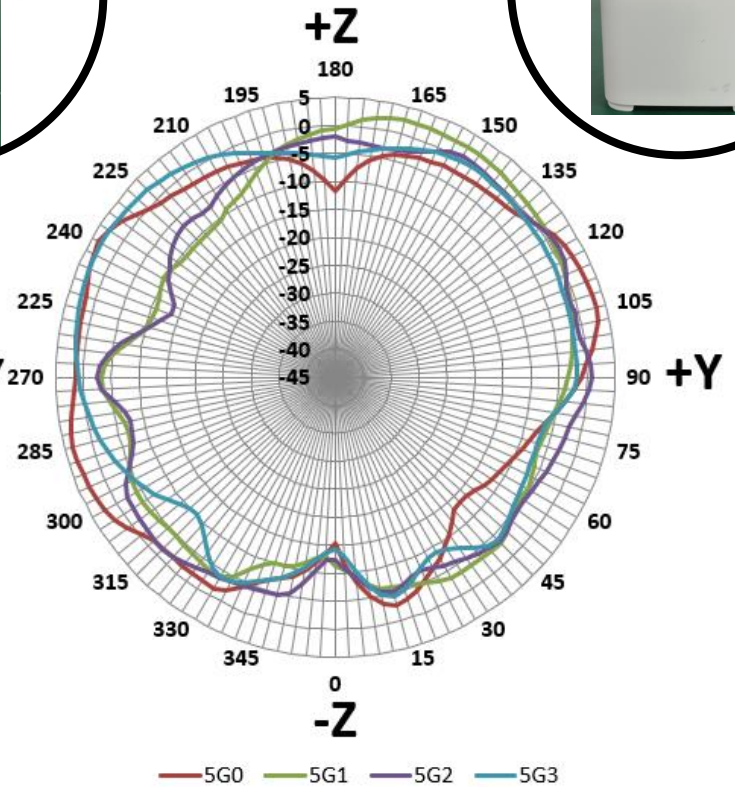




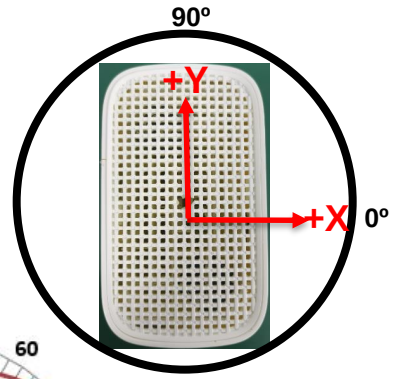


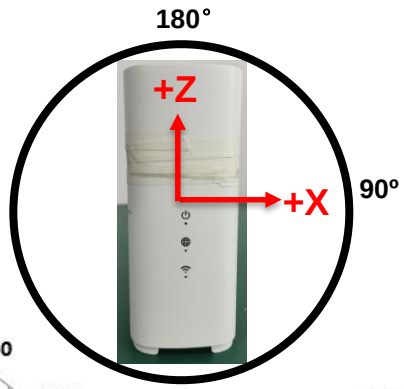


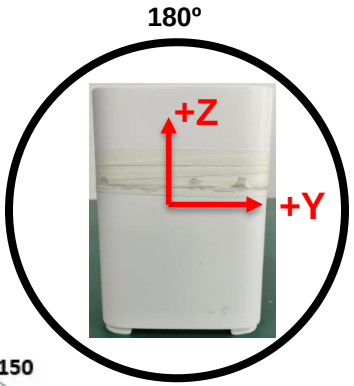


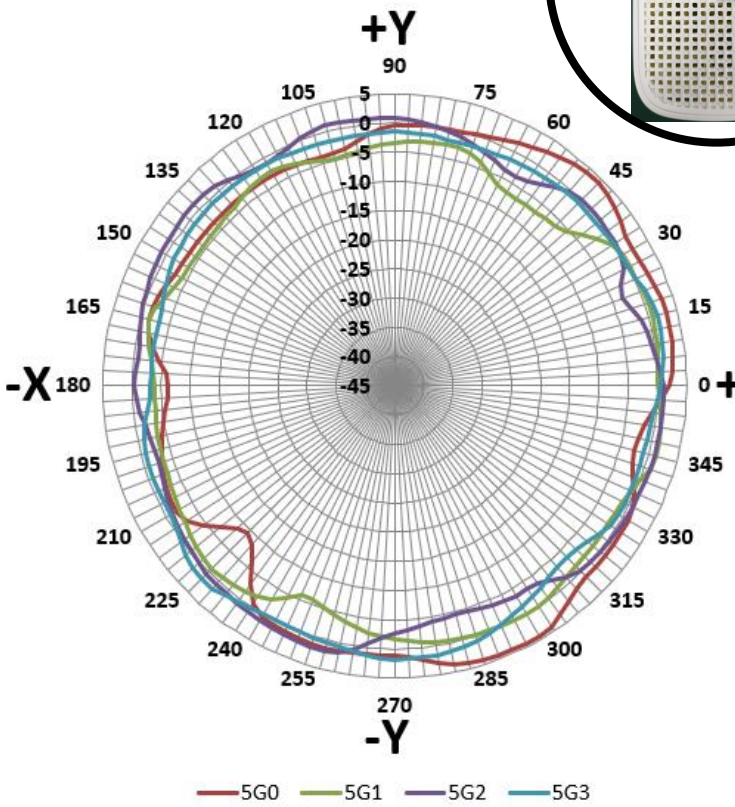


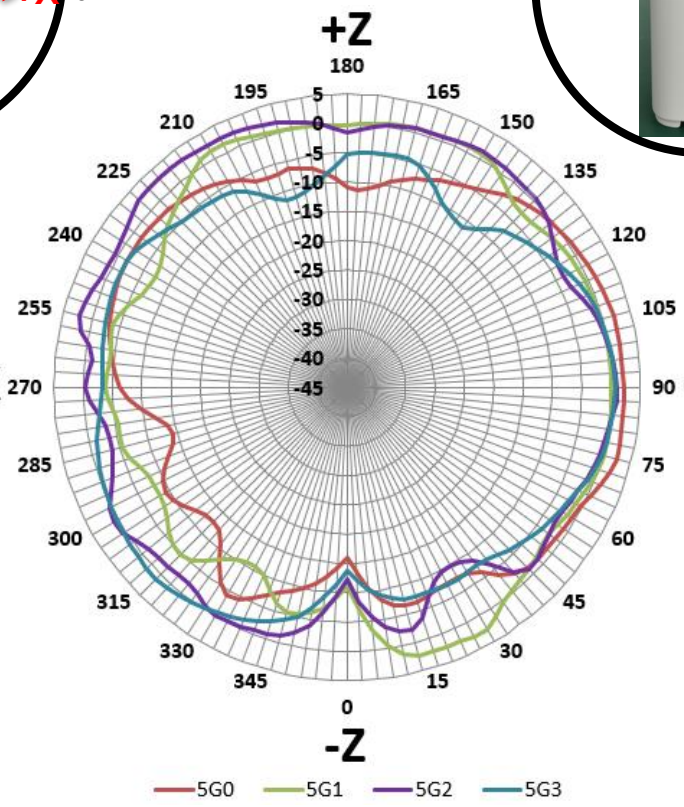
System Coverage- Gain [dB]
5750MHz

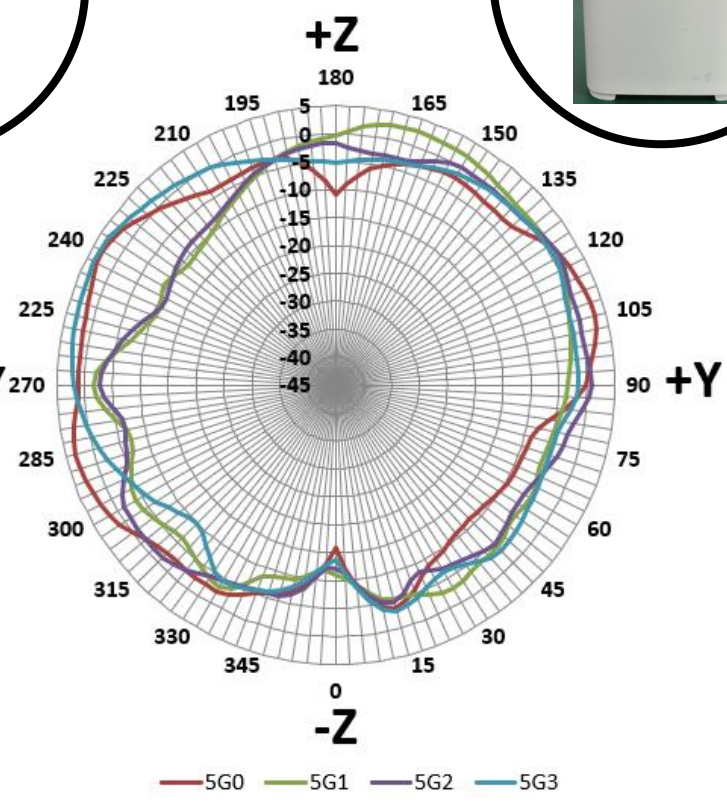




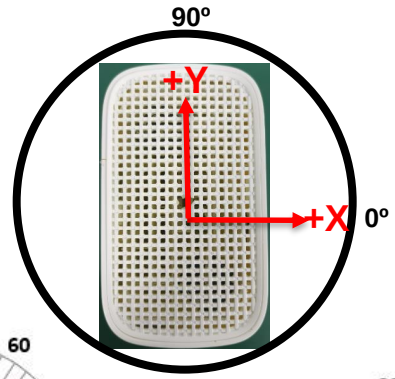


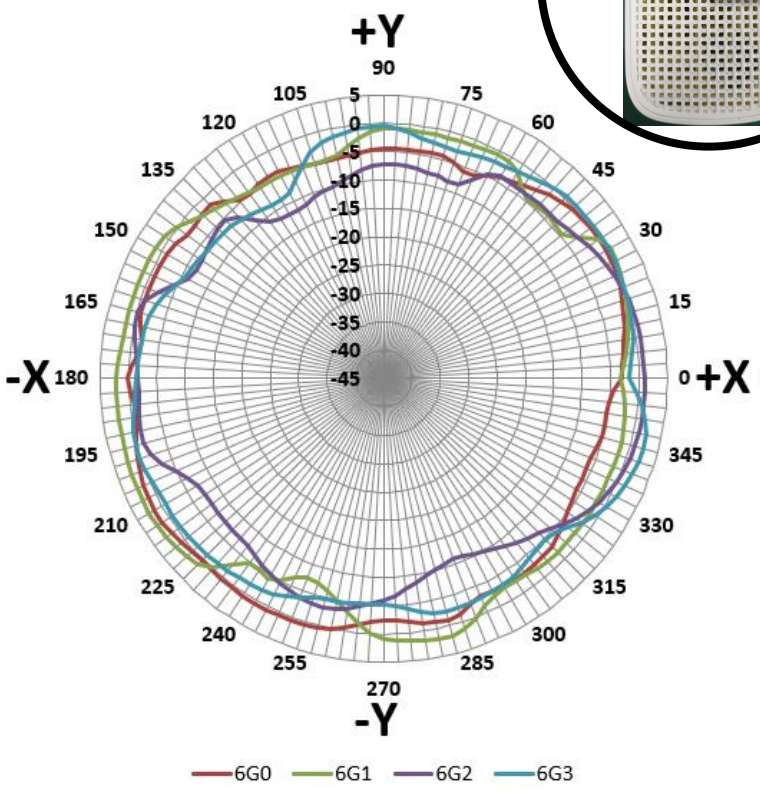


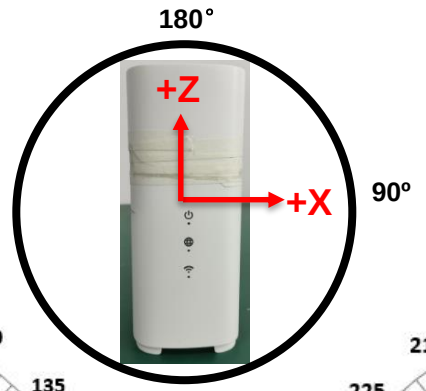


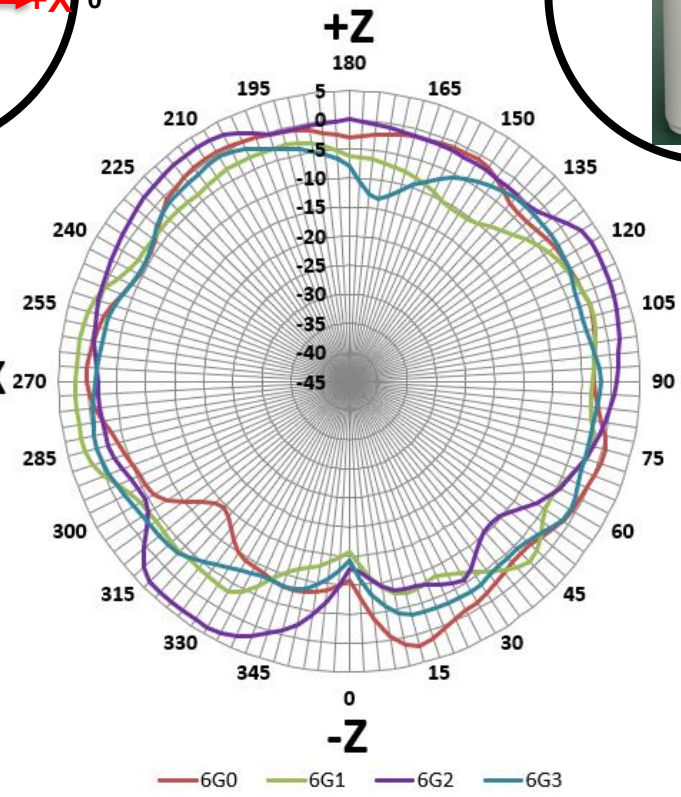


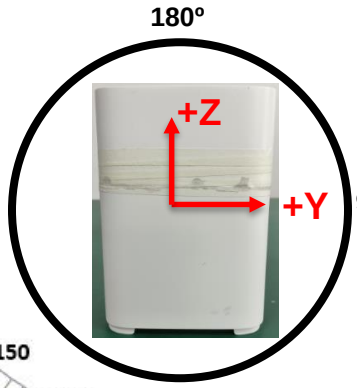
System Coverage- Gain [dB]
5945MHz

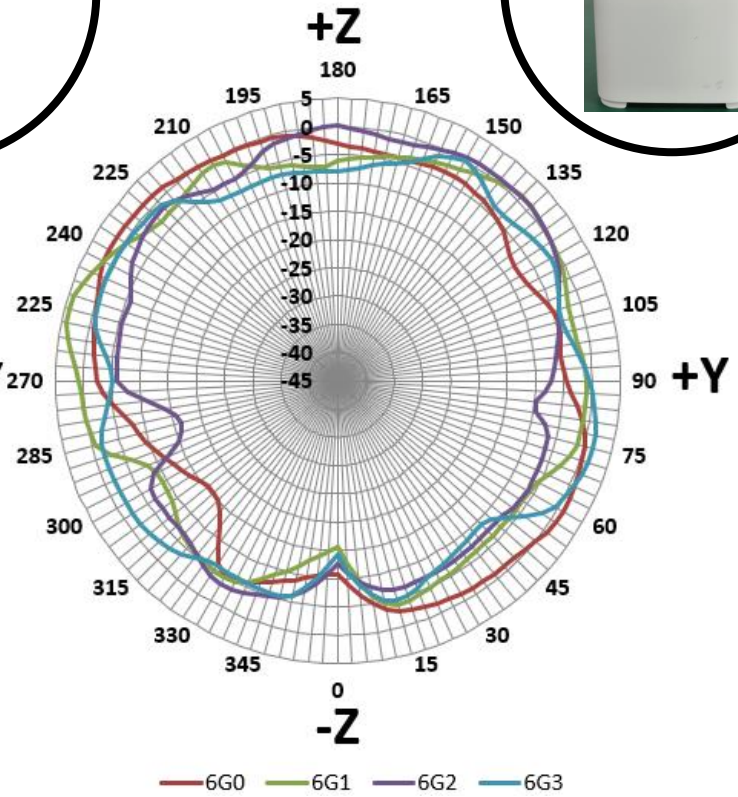




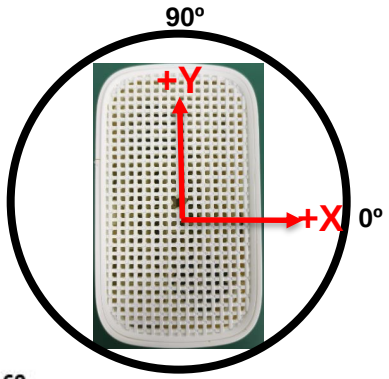


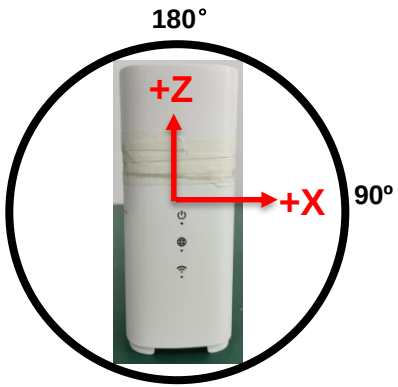


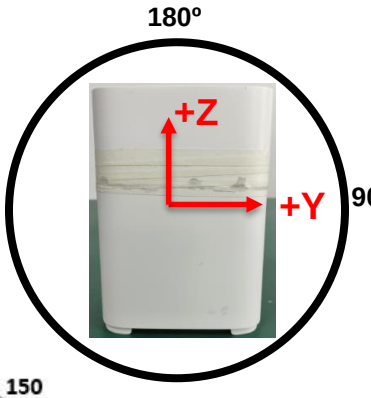


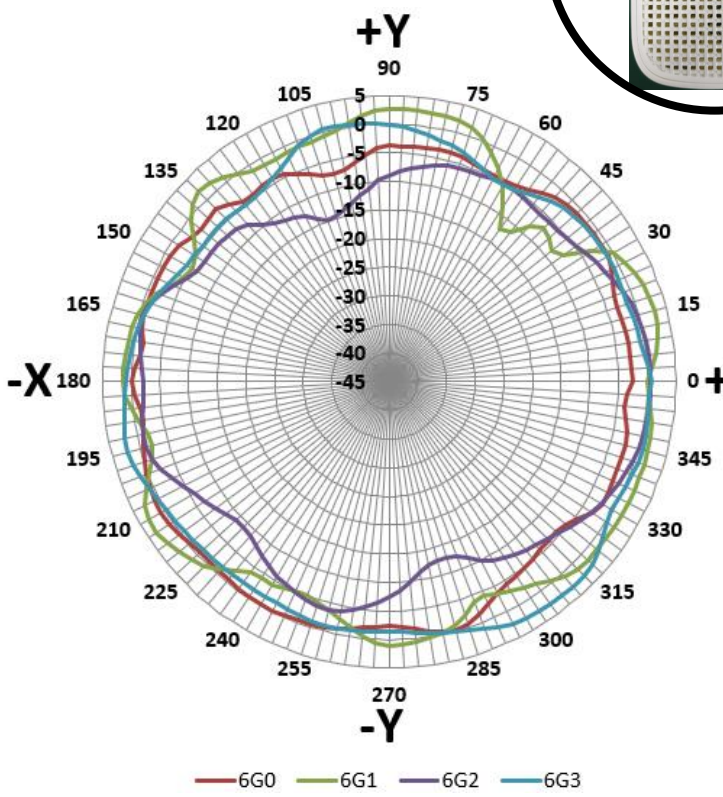


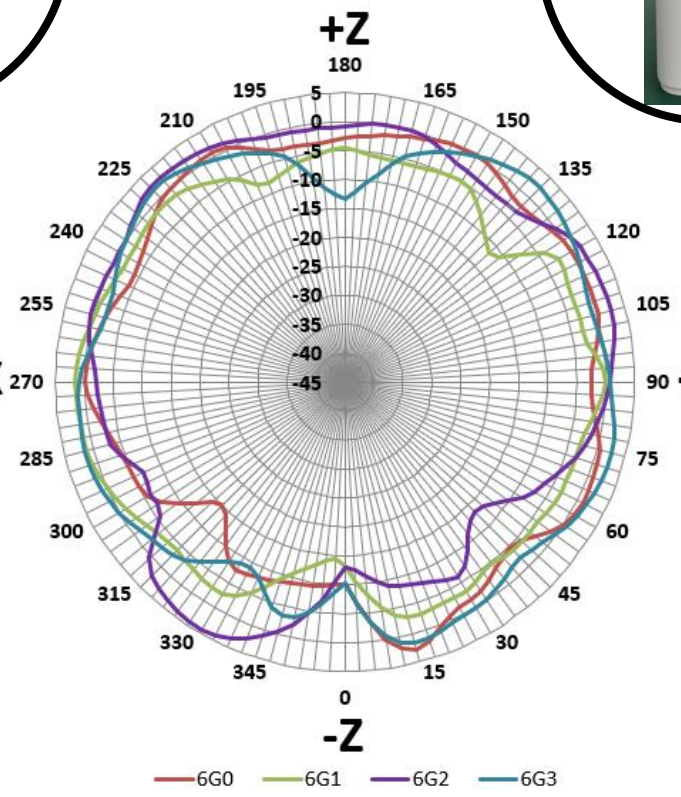
System Coverage- Gain [dB]
6500MHz

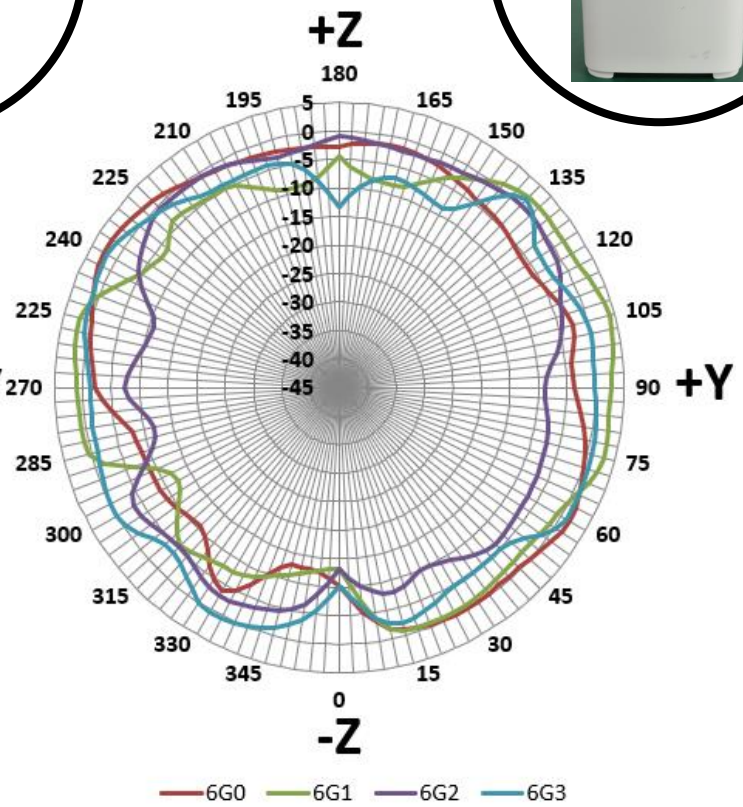




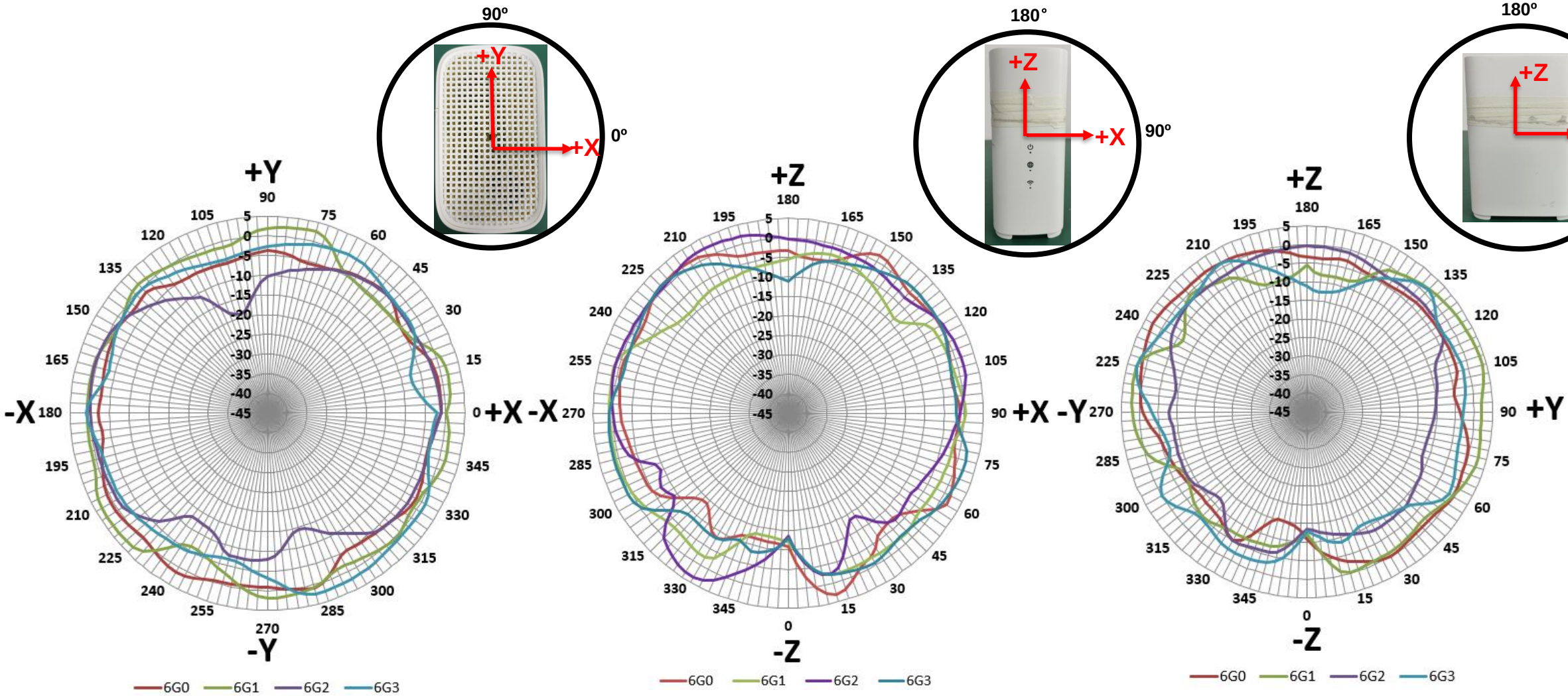








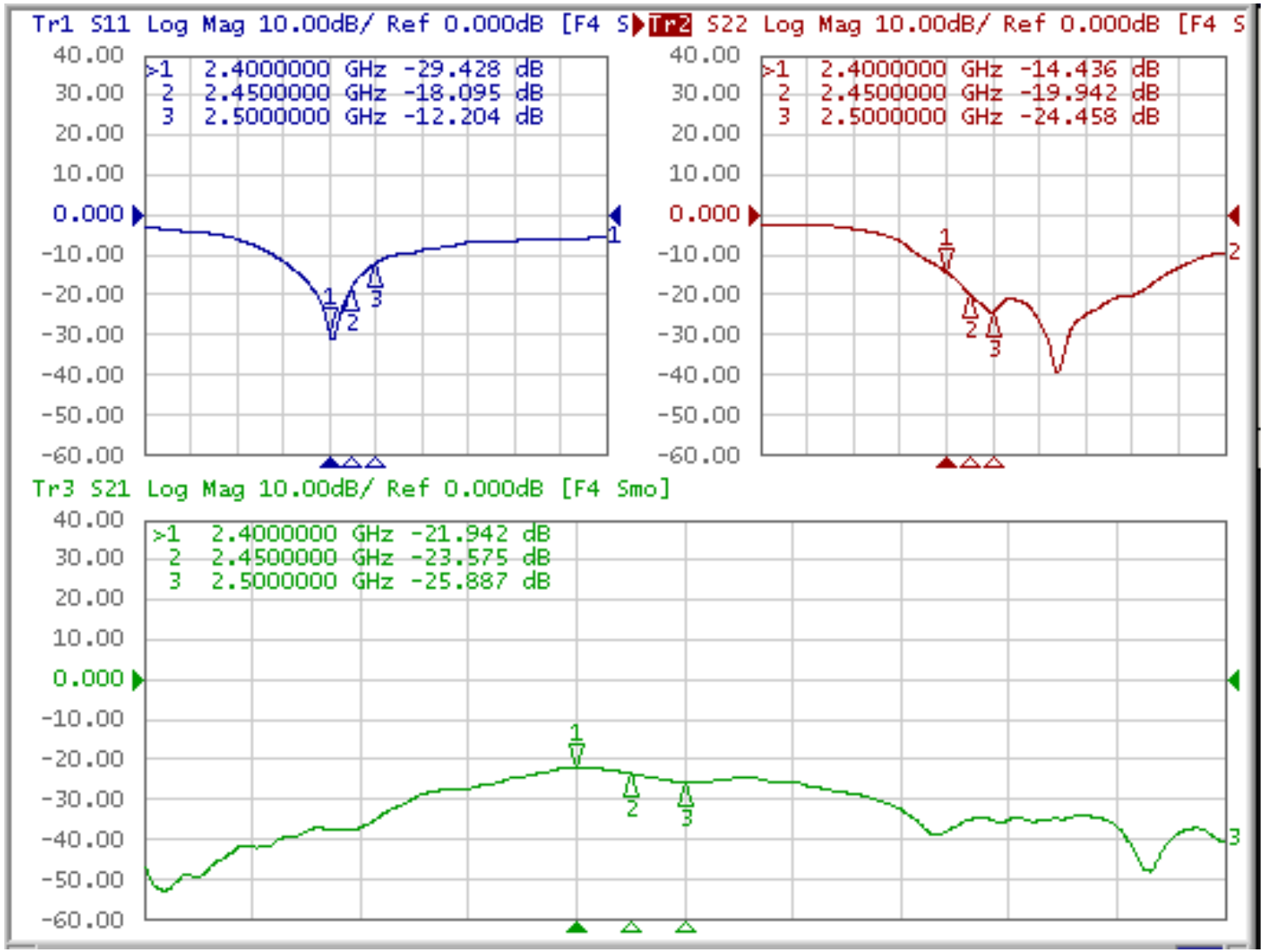
System Coverage- Gain [dB]
7125MHz

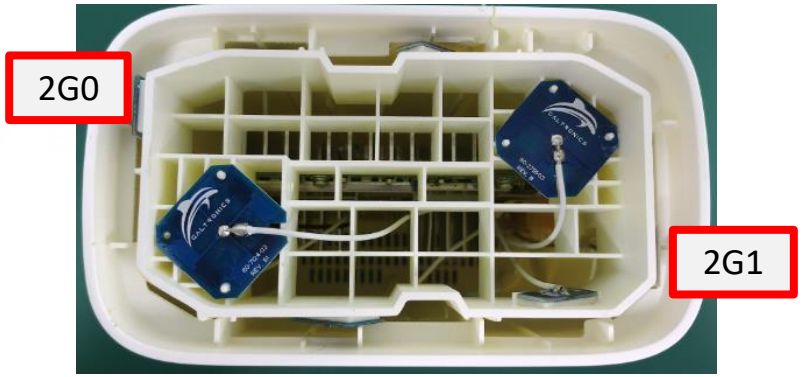


Antenna Return Loss and Isolation of 2G

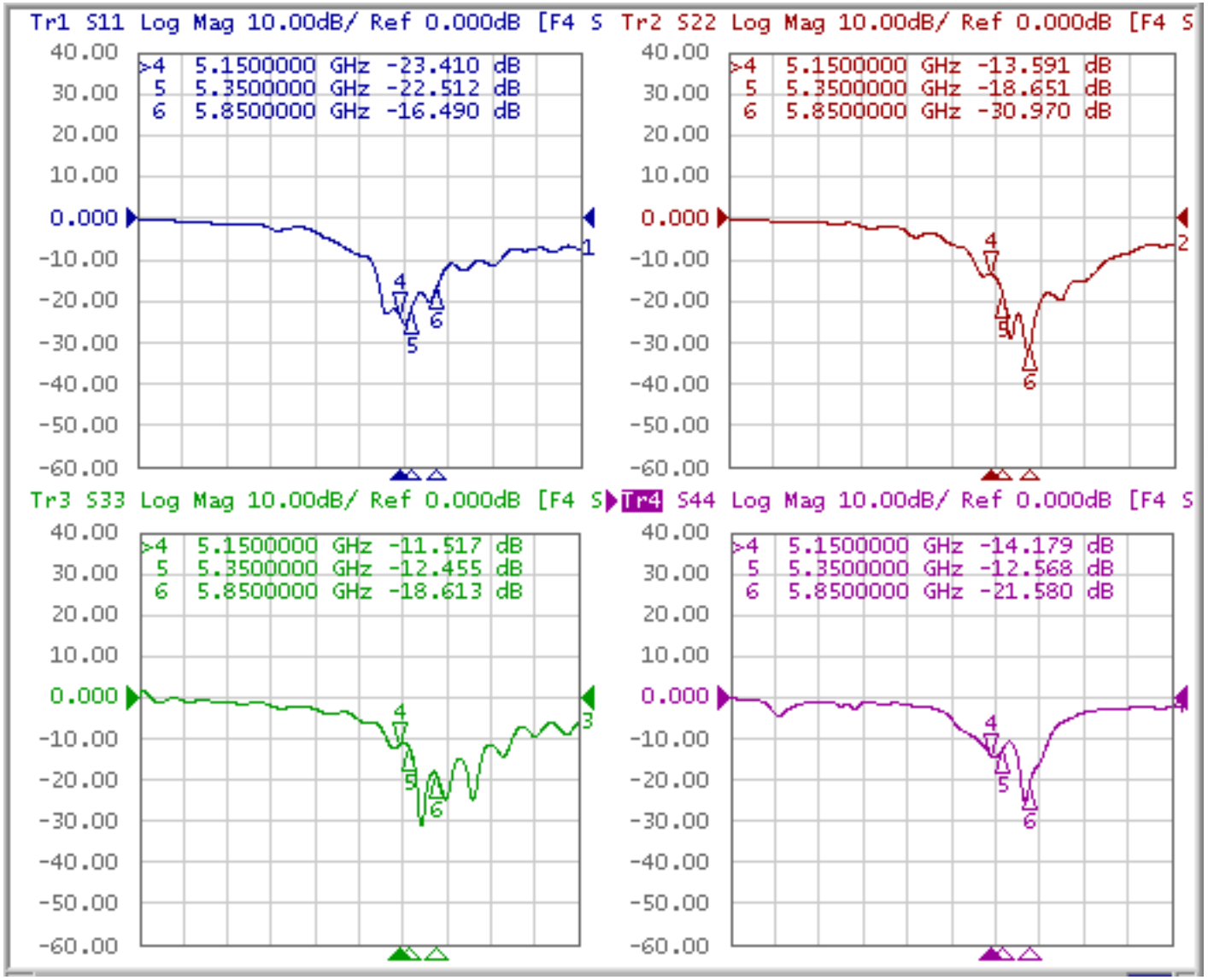
Port1= 2G0

Port2= 2G1





Antenna Return Loss of 5G

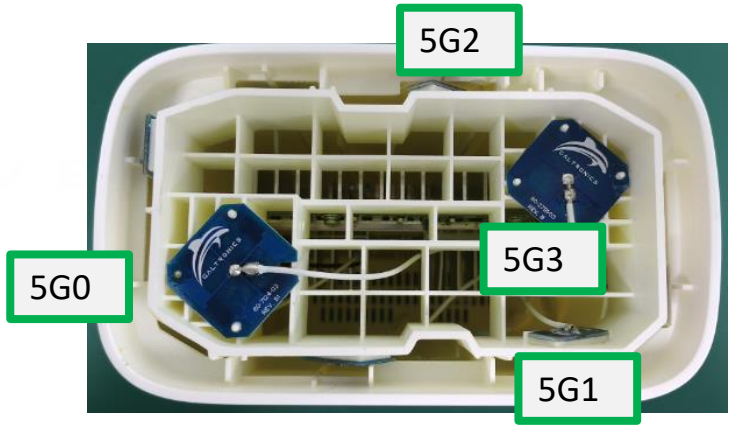


Port1= 5G0

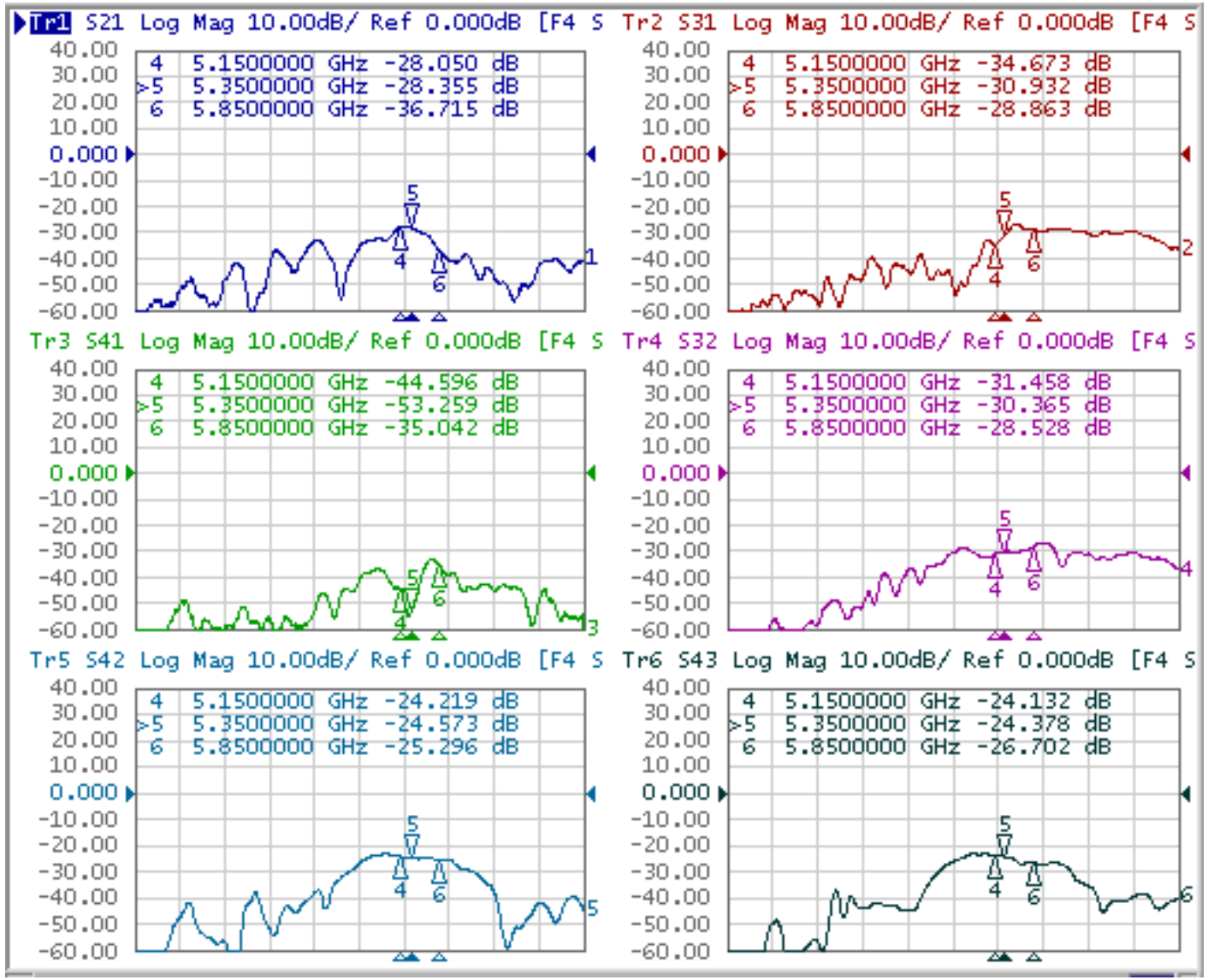
Port2= 5G1

Port3= 5G2

Port4= 5G3



Antenna Isolation of 5G

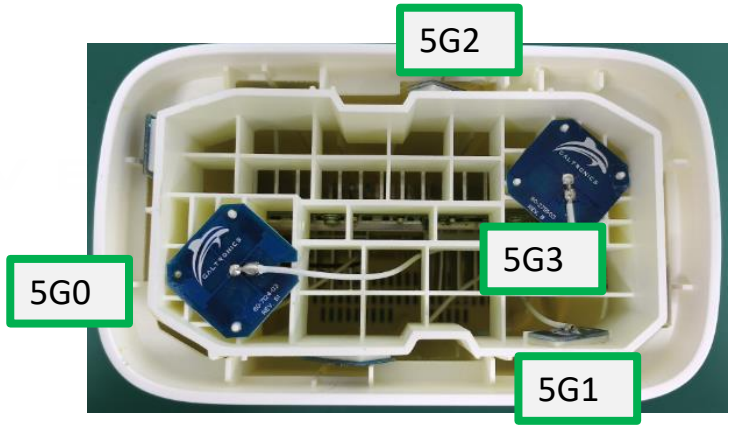


Port1= 5G0

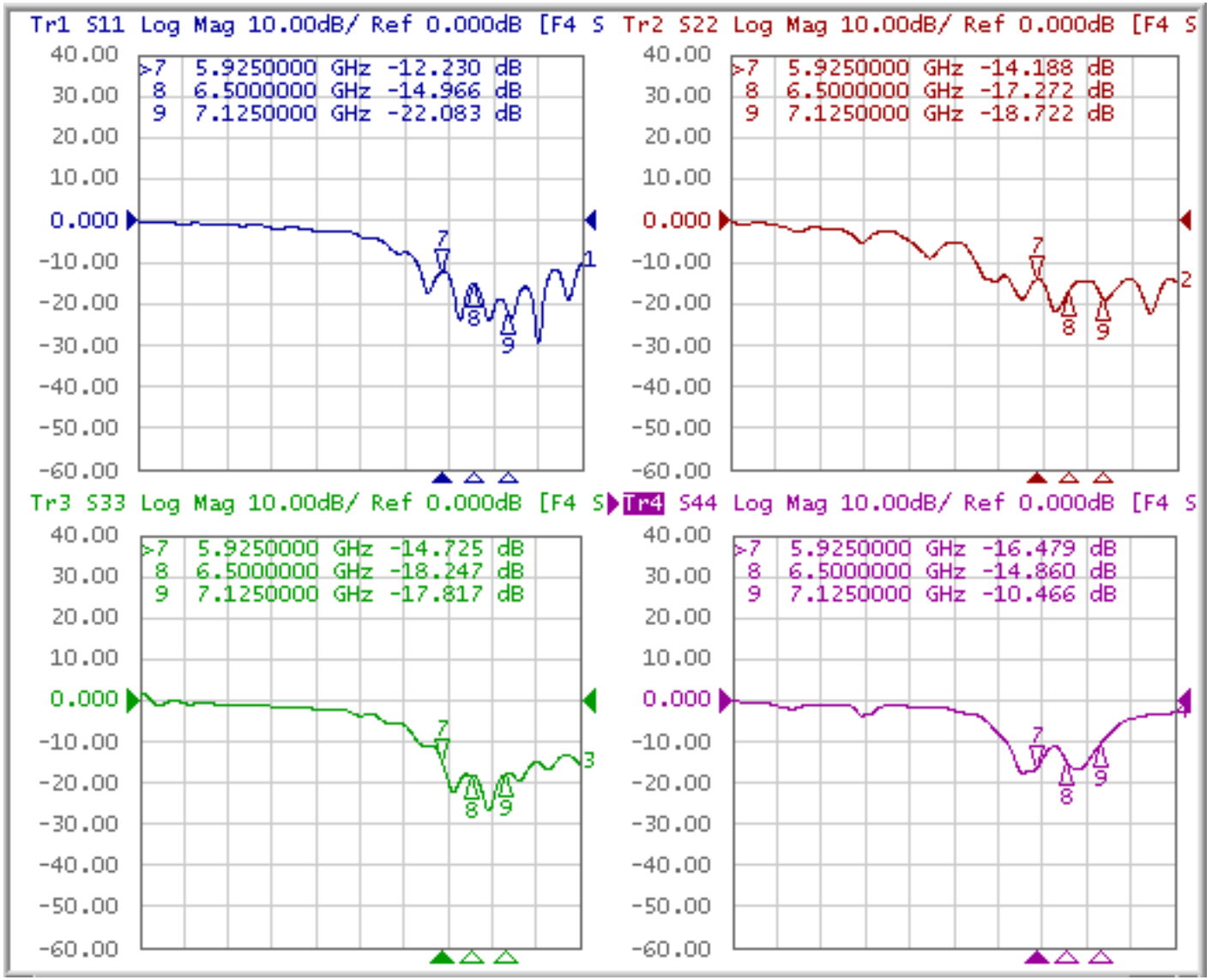
Port2= 5G1

Port3= 5G2

Port4= 5G3



Antenna Return Loss of 6G

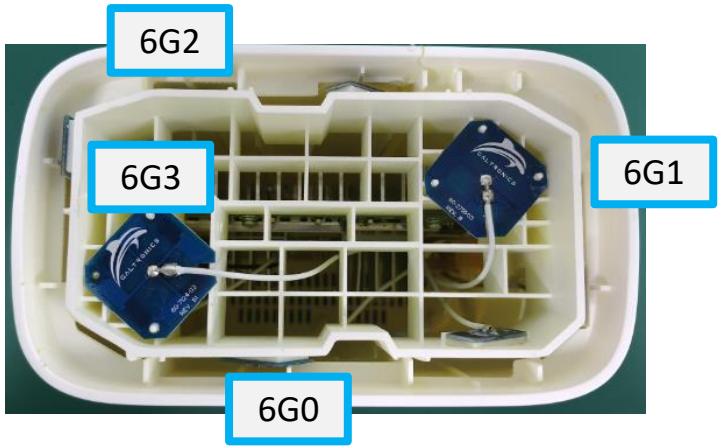


Port1= 6G0

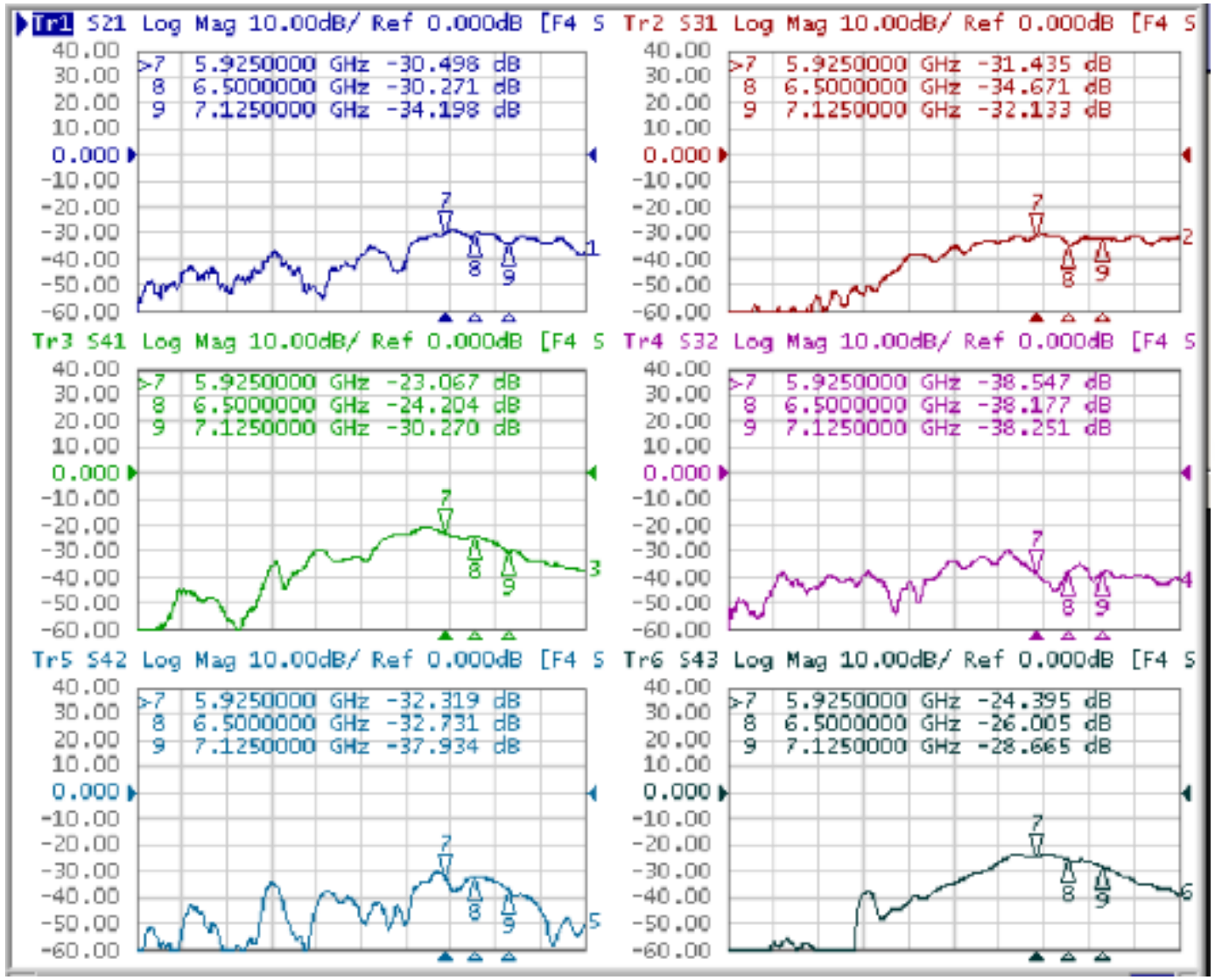
Port2= 6G1

Port3= 6G2

Port4= 6G3



Antenna Isolation of 6G

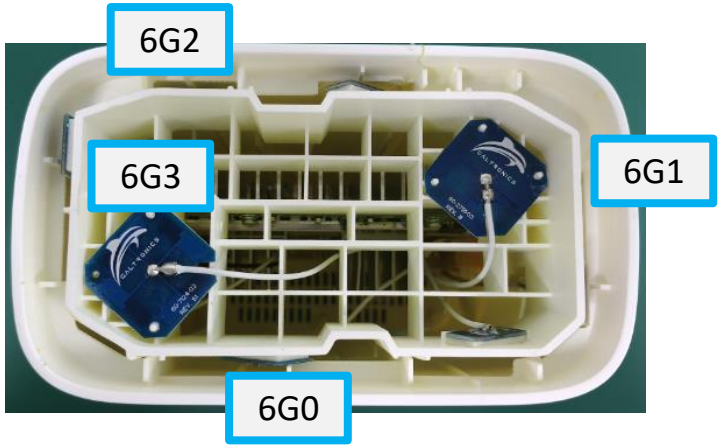


Port1= 6G0

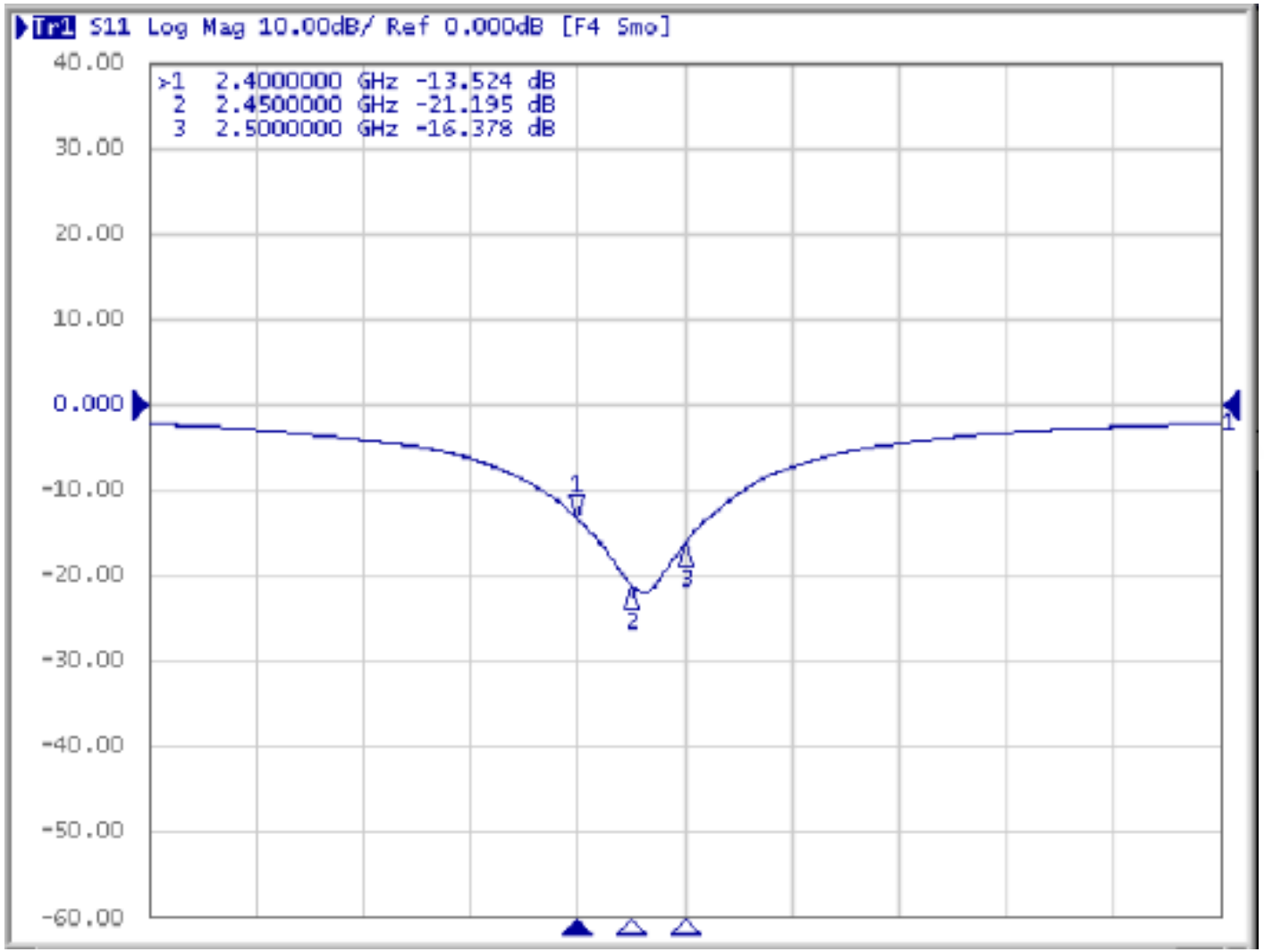
Port2= 6G1

Port3= 6G2

Port4= 6G3

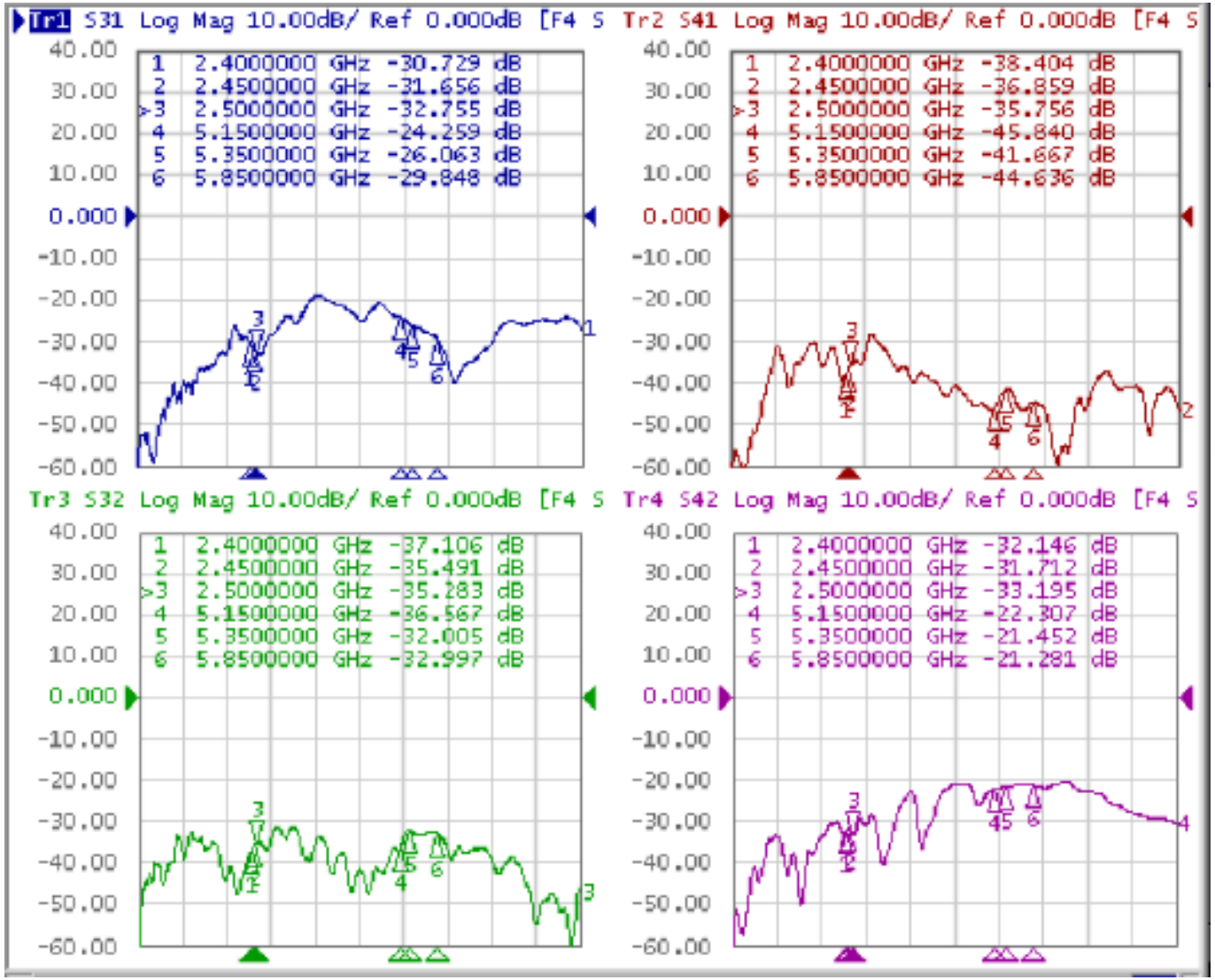


Antenna Return Loss of BT



Port1= BT

Antenna Isolation of the 2G and 5G

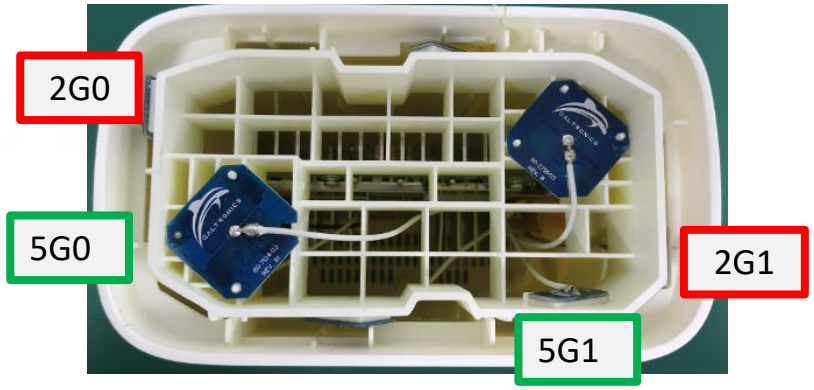


Port1= 2G0

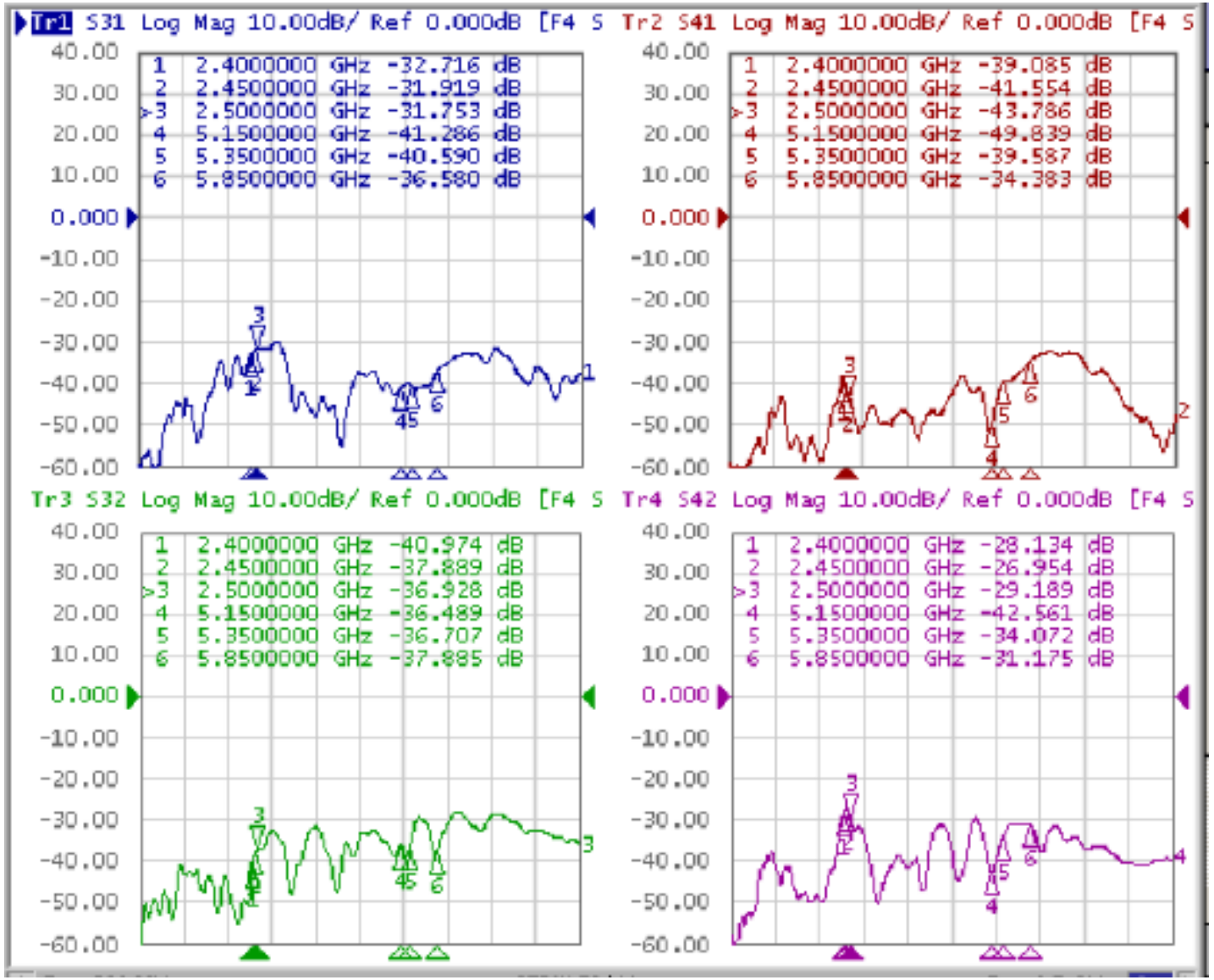
Port2= 2G1

Port3= 5G0

Port4= 5G1



Antenna Isolation of the 2G and 5G

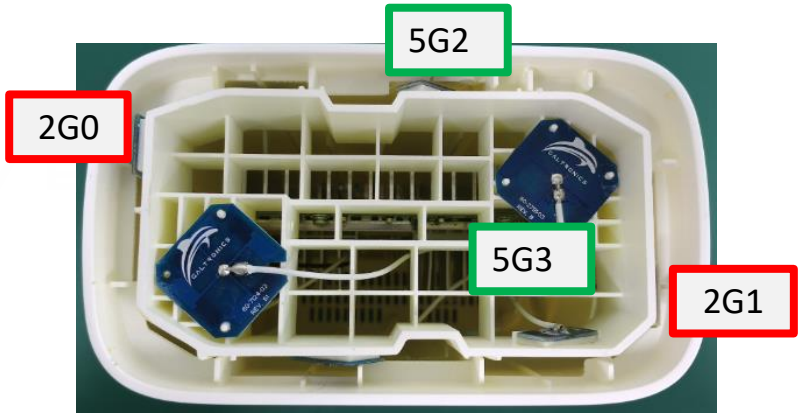


Port1= 2G0

Port2= 2G1

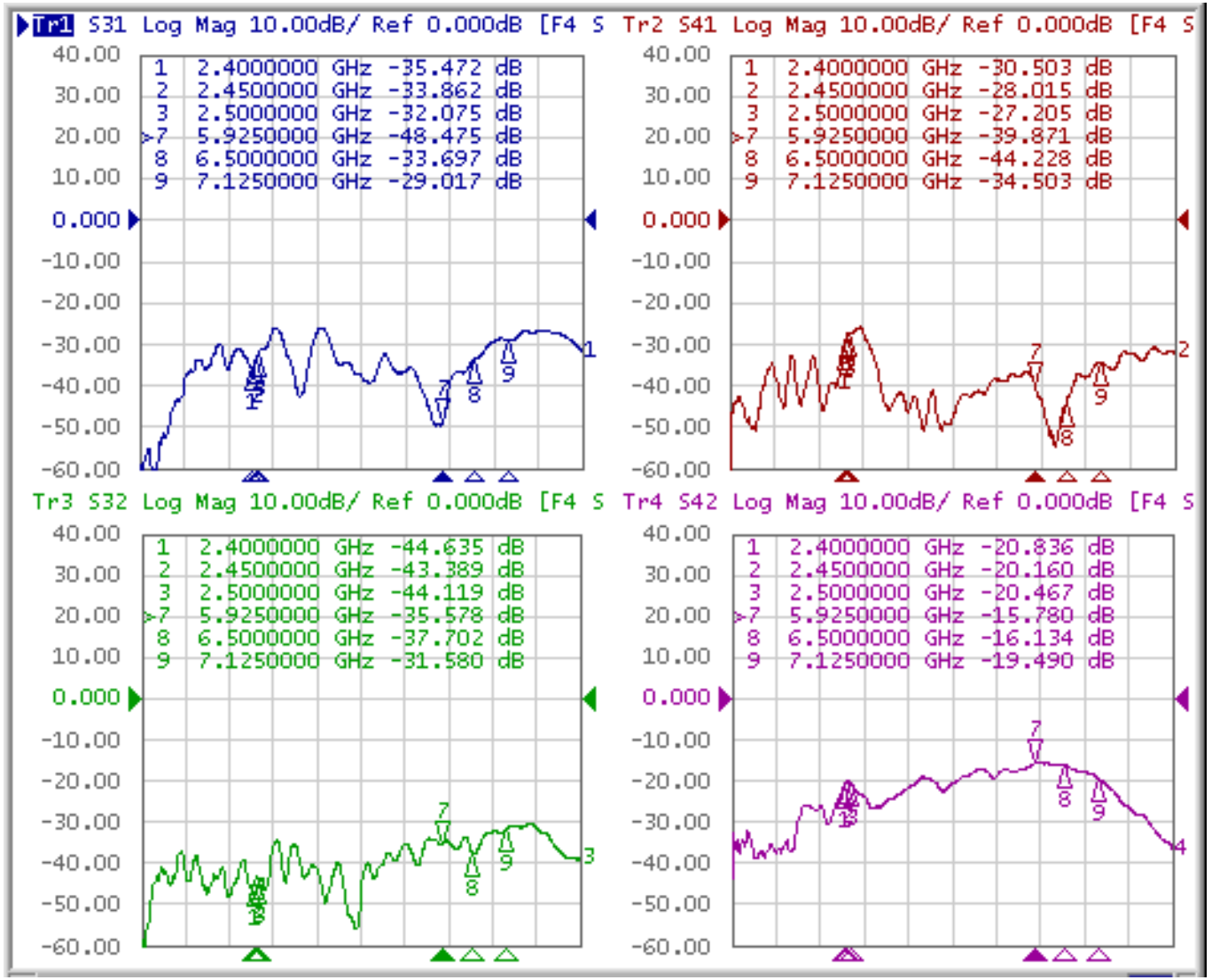
Port3= 5G2

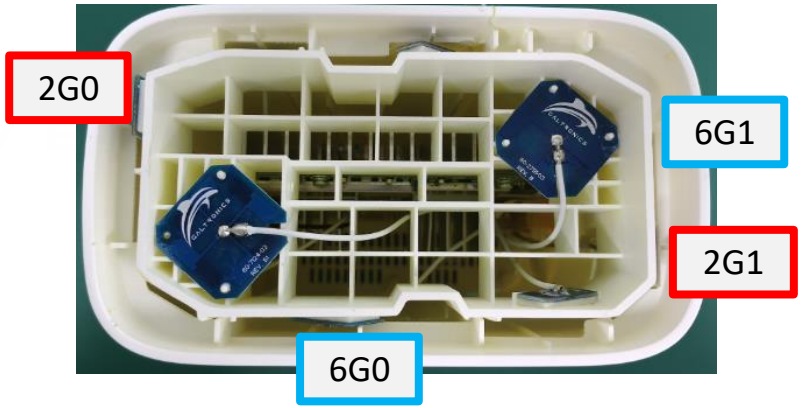
Port4= 5G3



Antenna Isolation of the 2G and 6G

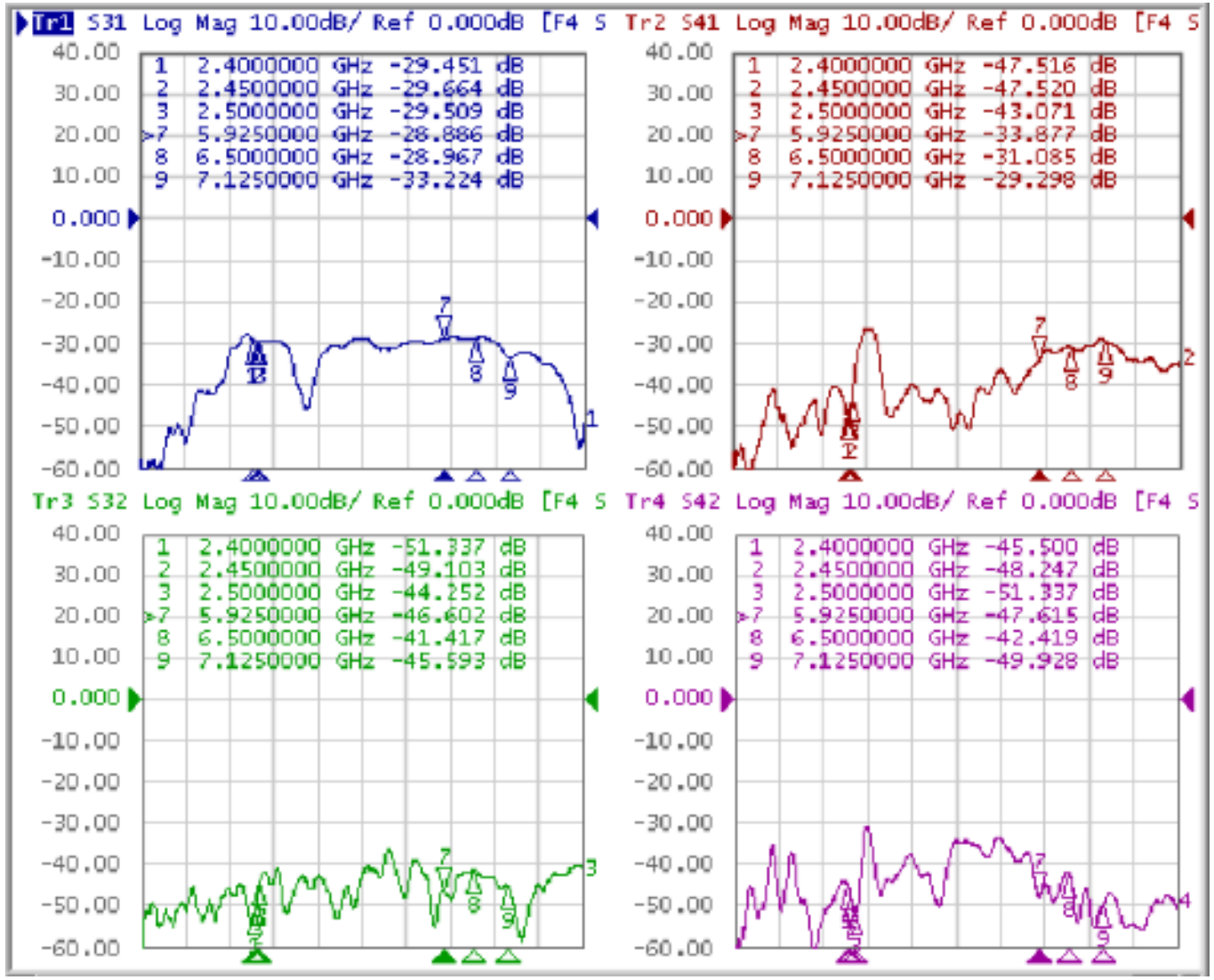
Port1= 2G0
Port2= 2G1
Port3= 6G0
Port4= 6G1

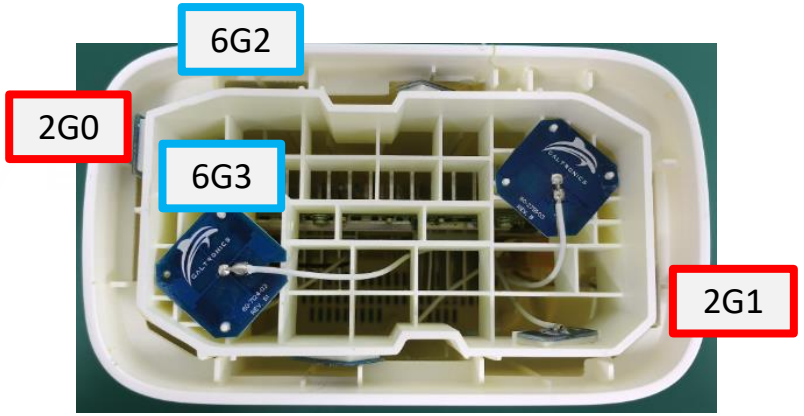




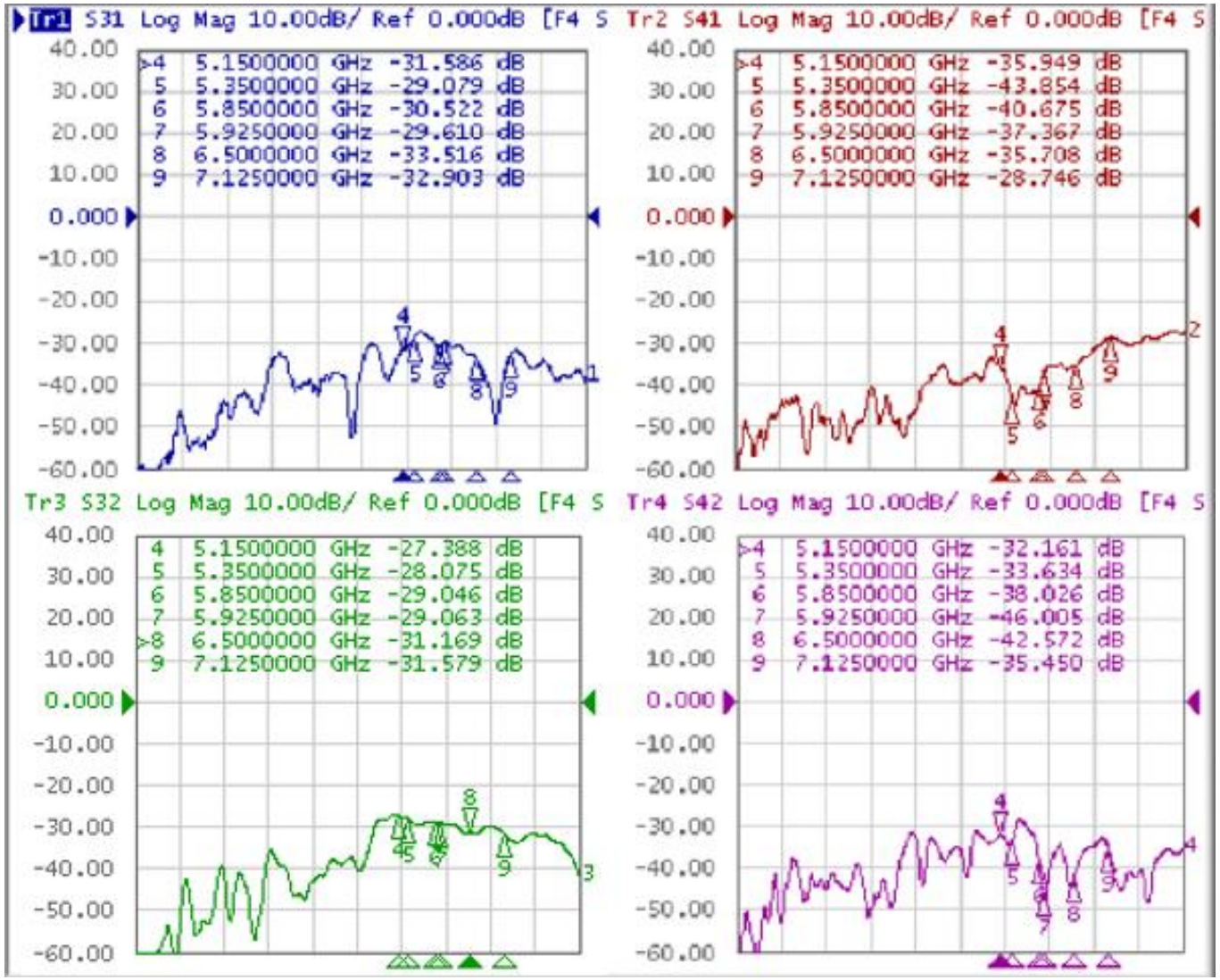
Antenna Isolation of the 2G and 6G

Port1= 2G0
Port2= 2G1
Port3= 6G2
Port4= 6G3

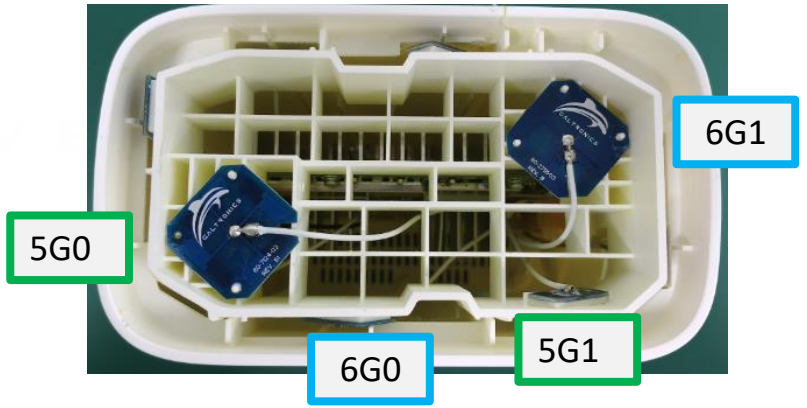




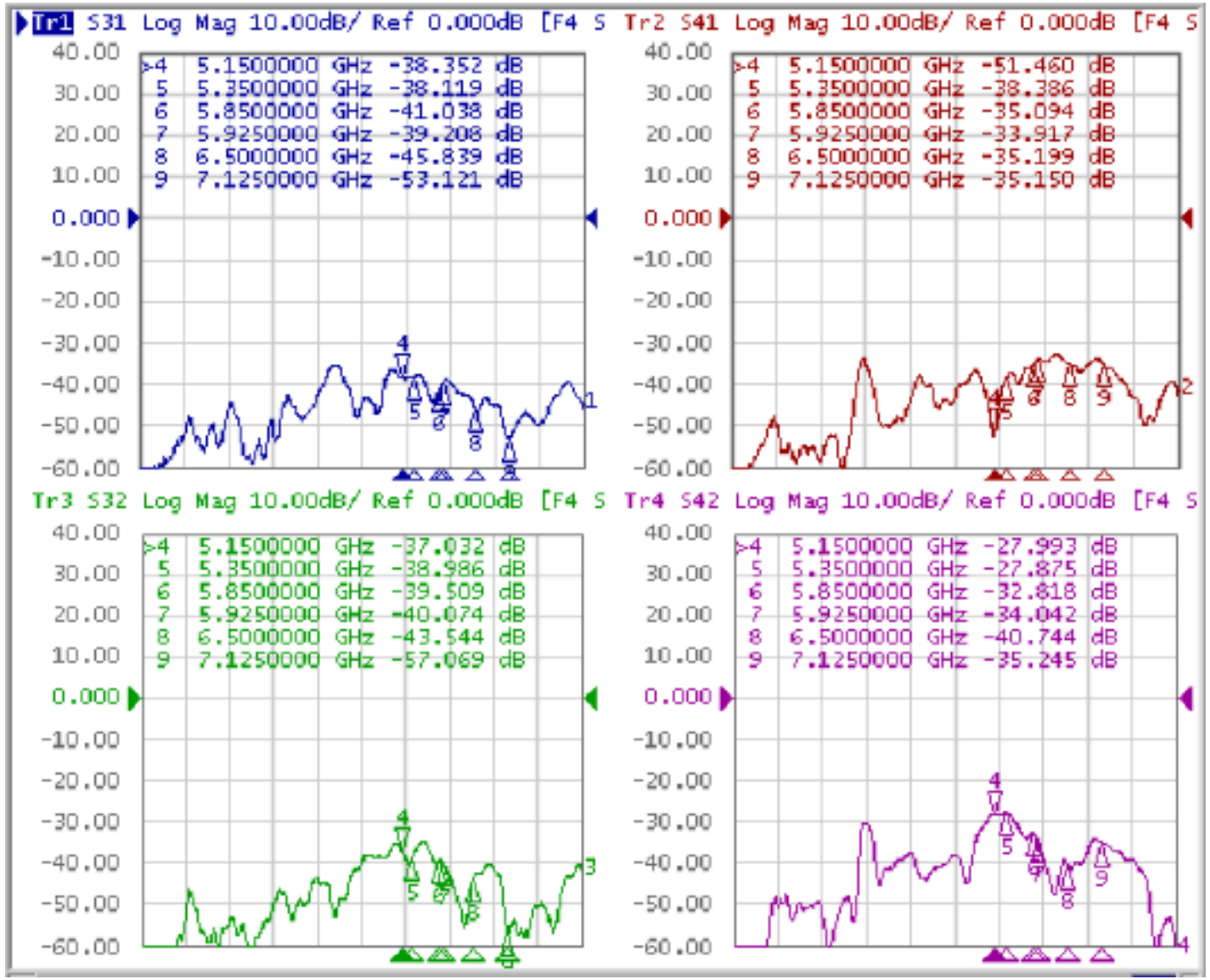
Antenna Isolation of the 5G and 6G



- Port1= 5G0
- Port2= 5G1
- Port3= 6G0
- Port4= 6G1



Antenna Isolation of the 5G and 6G

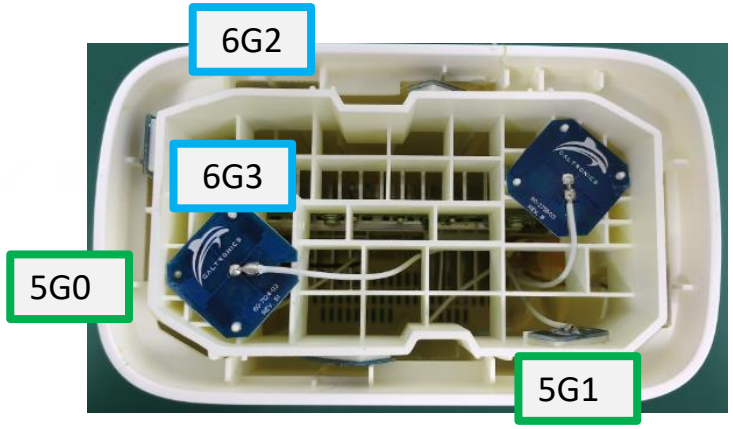


Port1= 5G0

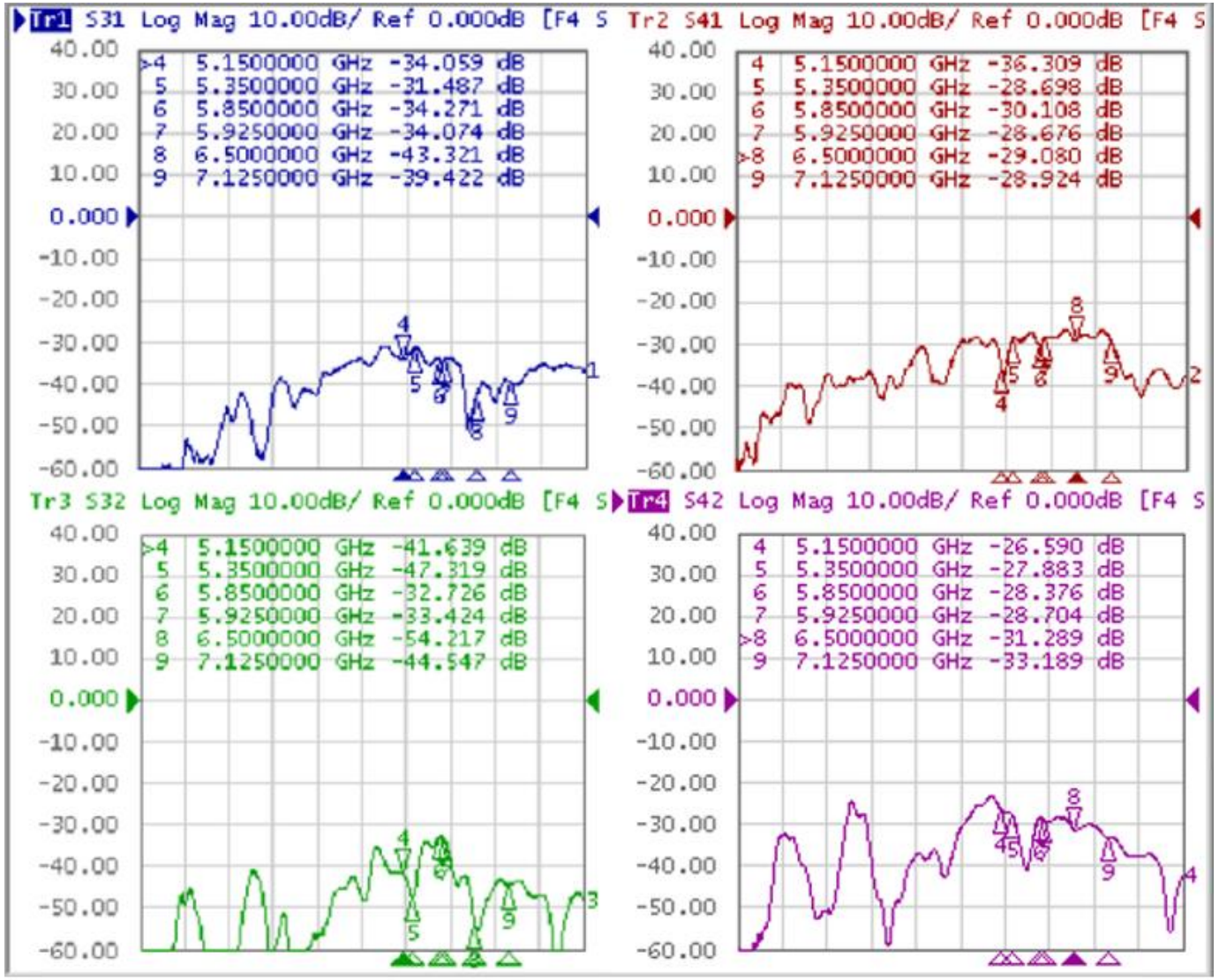
Port2= 5G1

Port3= 6G2

Port4= 6G3



Antenna Isolation of the 5G and 6G

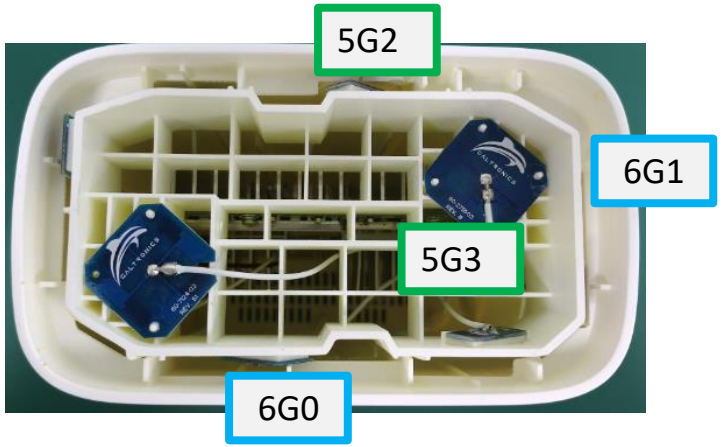


Port1= 5G2

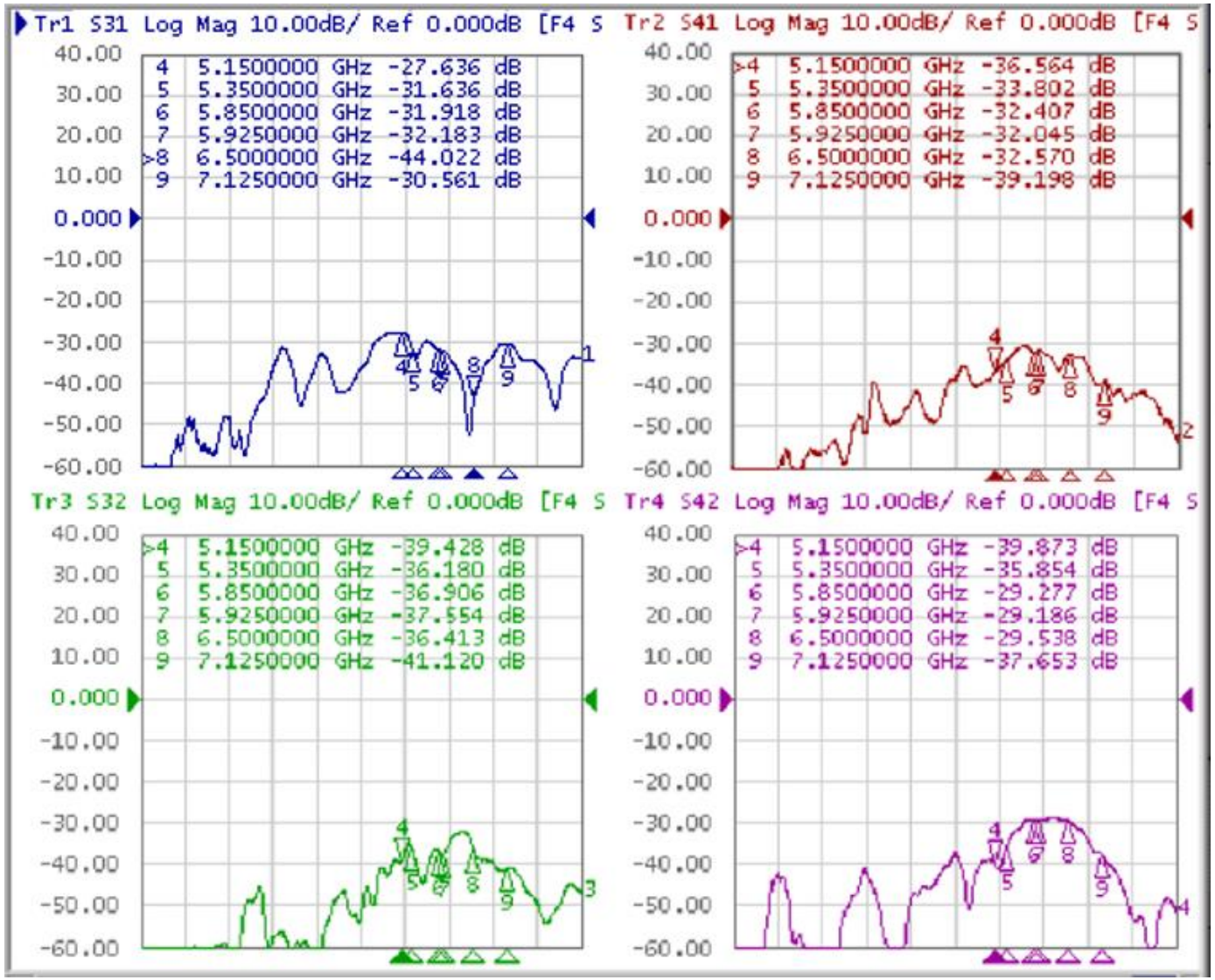
Port2= 5G3

Port3= 6G0

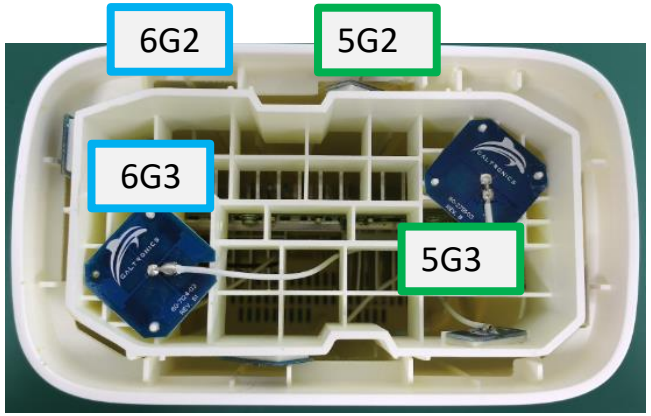
Port4= 6G1



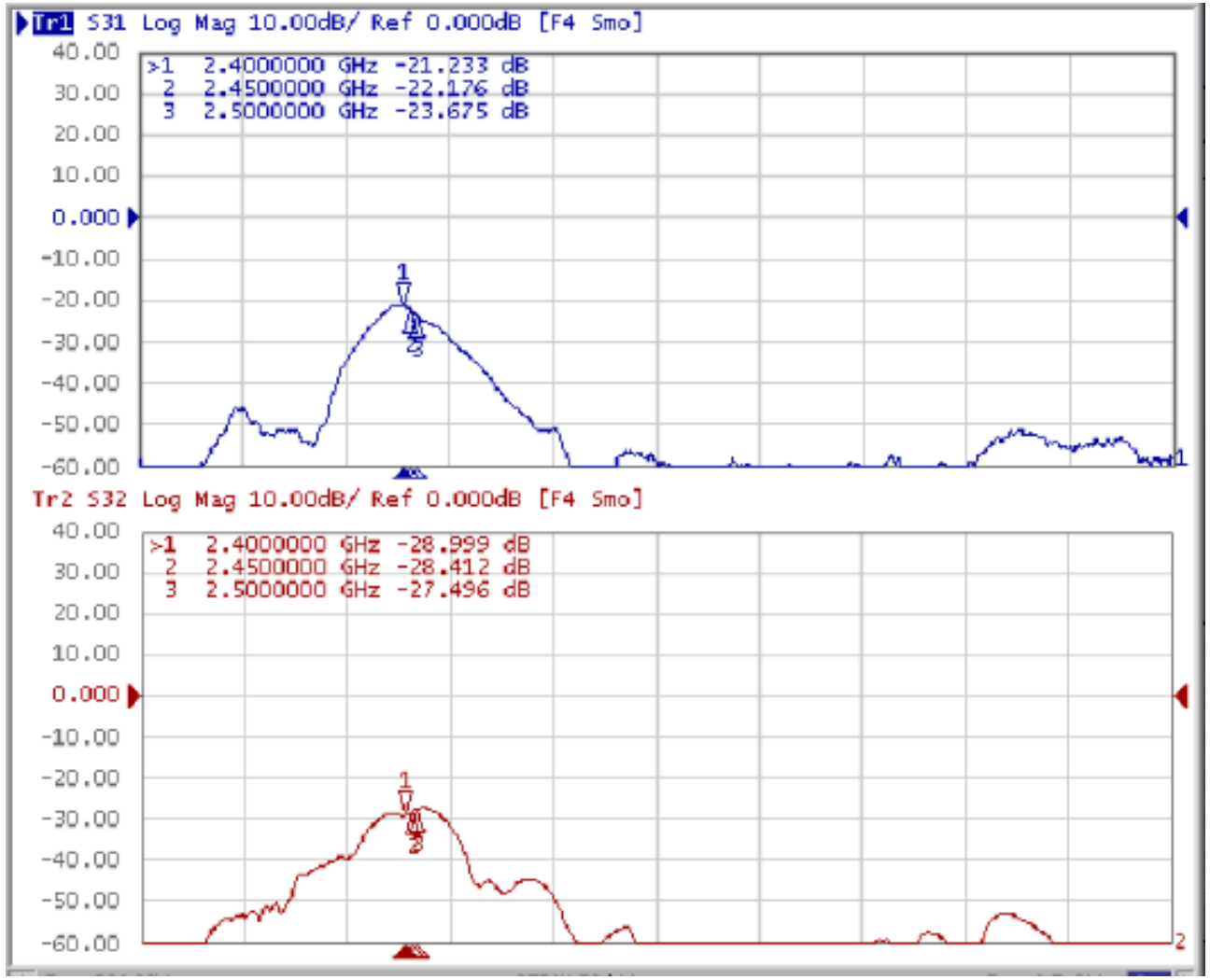
Antenna Isolation of the 5G and 6G



- Port1= 5G2
- Port2= 5G3
- Port3= 6G2
- Port4= 6G3



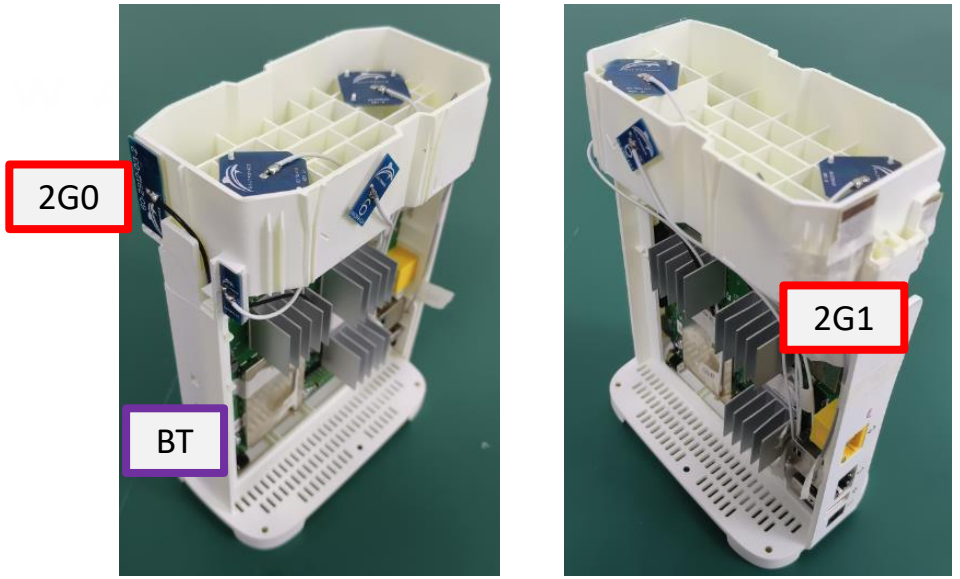
Antenna Isolation of the 2G and BT



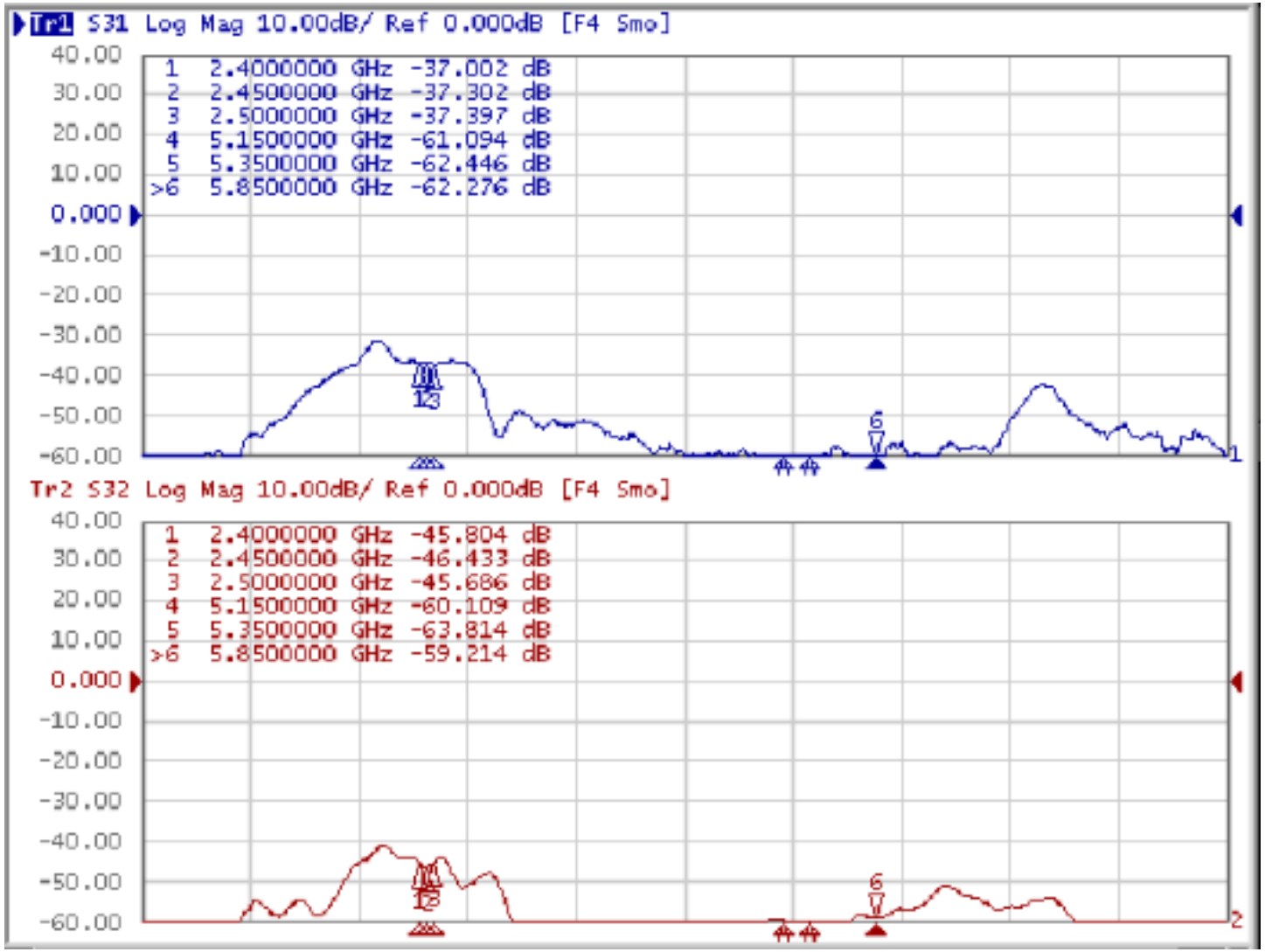
Port1= 2G0

Port2= 2G1

Port3= BT



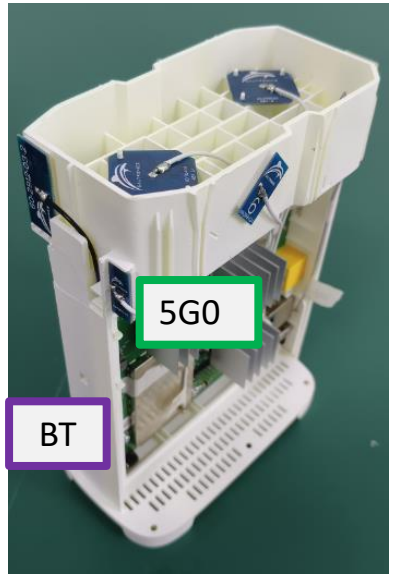
Antenna Isolation of the 5G and BT



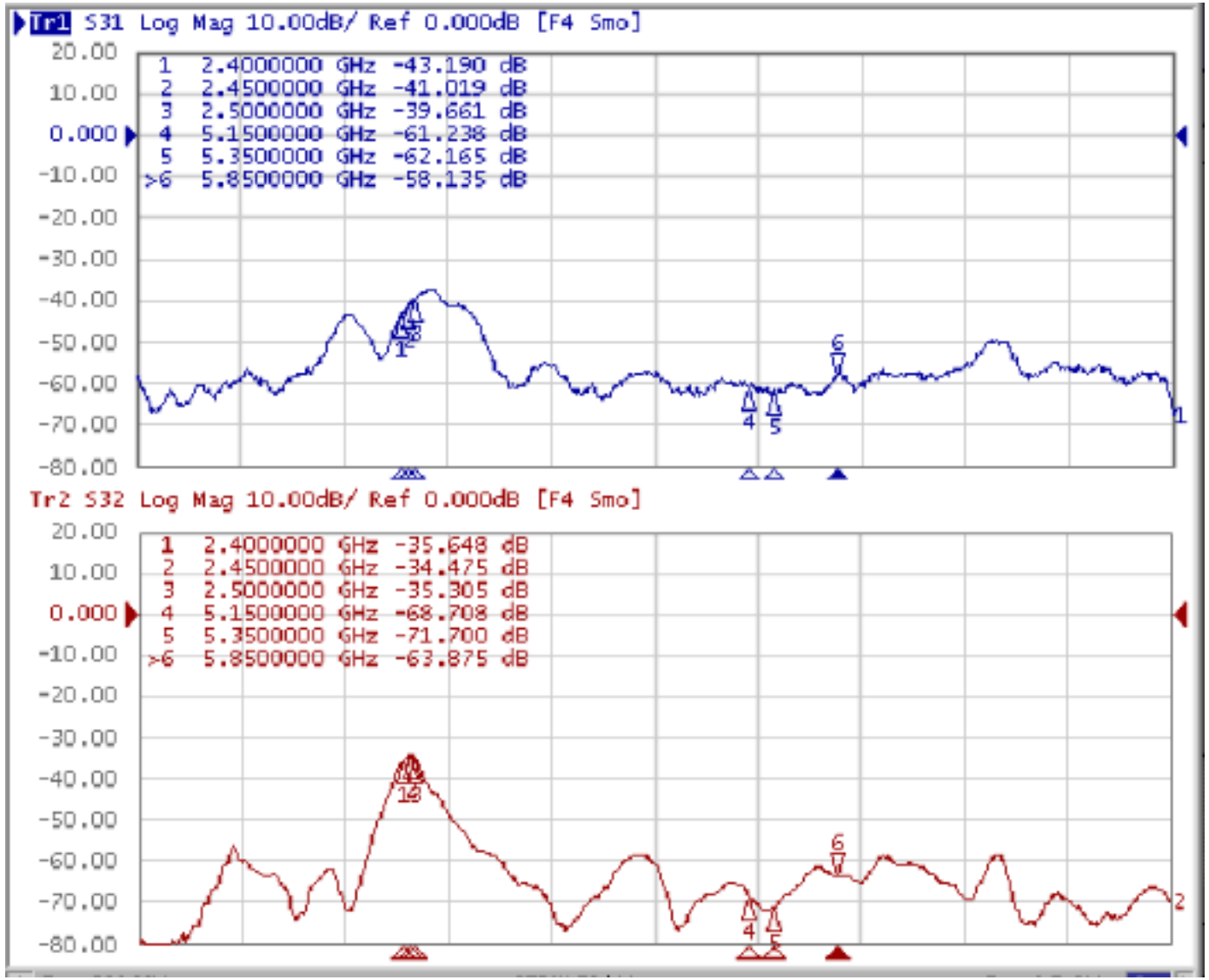
Port1= 5G0

Port2= 5G1

Port3= BT



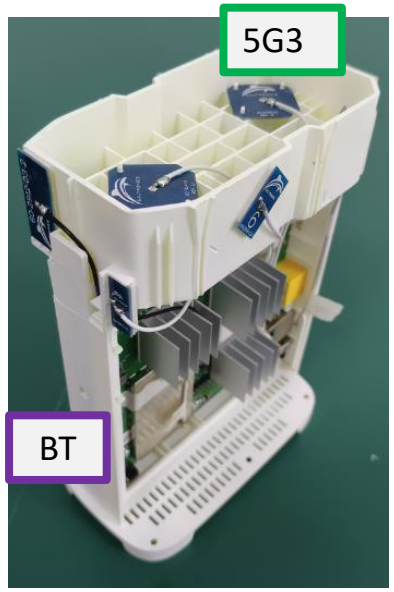
Antenna Isolation of the 5G and BT



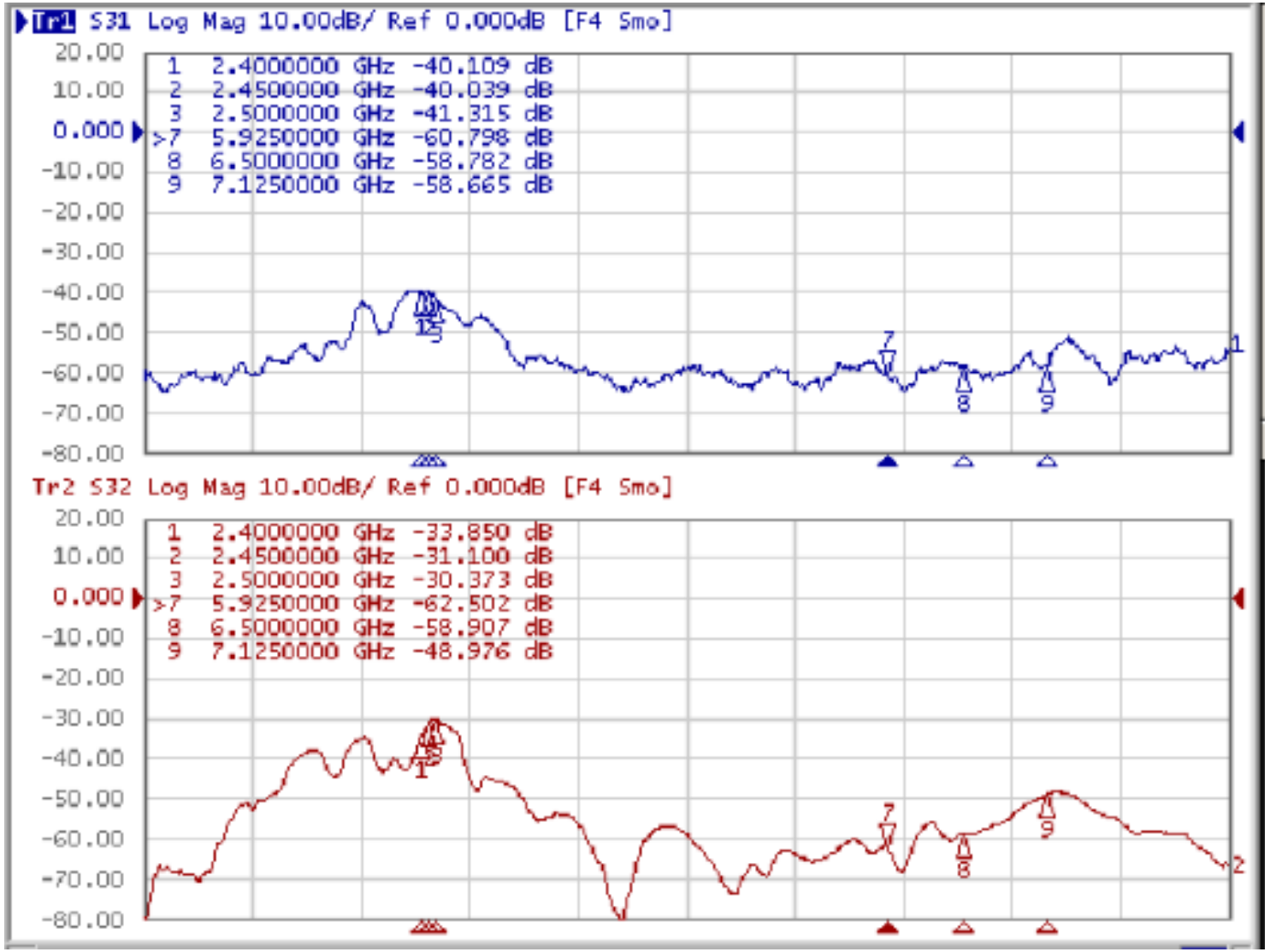
Port1= 5G2

Port2= 5G3

Port3= BT



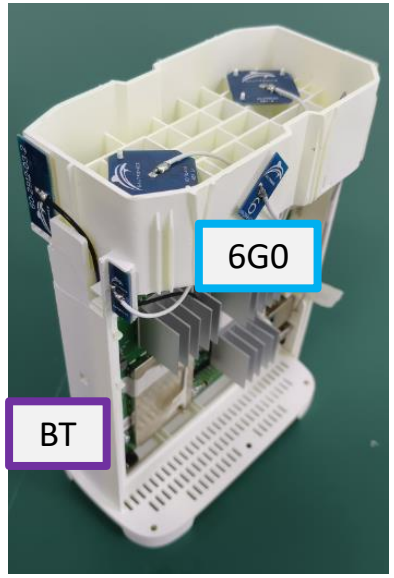
Antenna Isolation of the 6G and BT



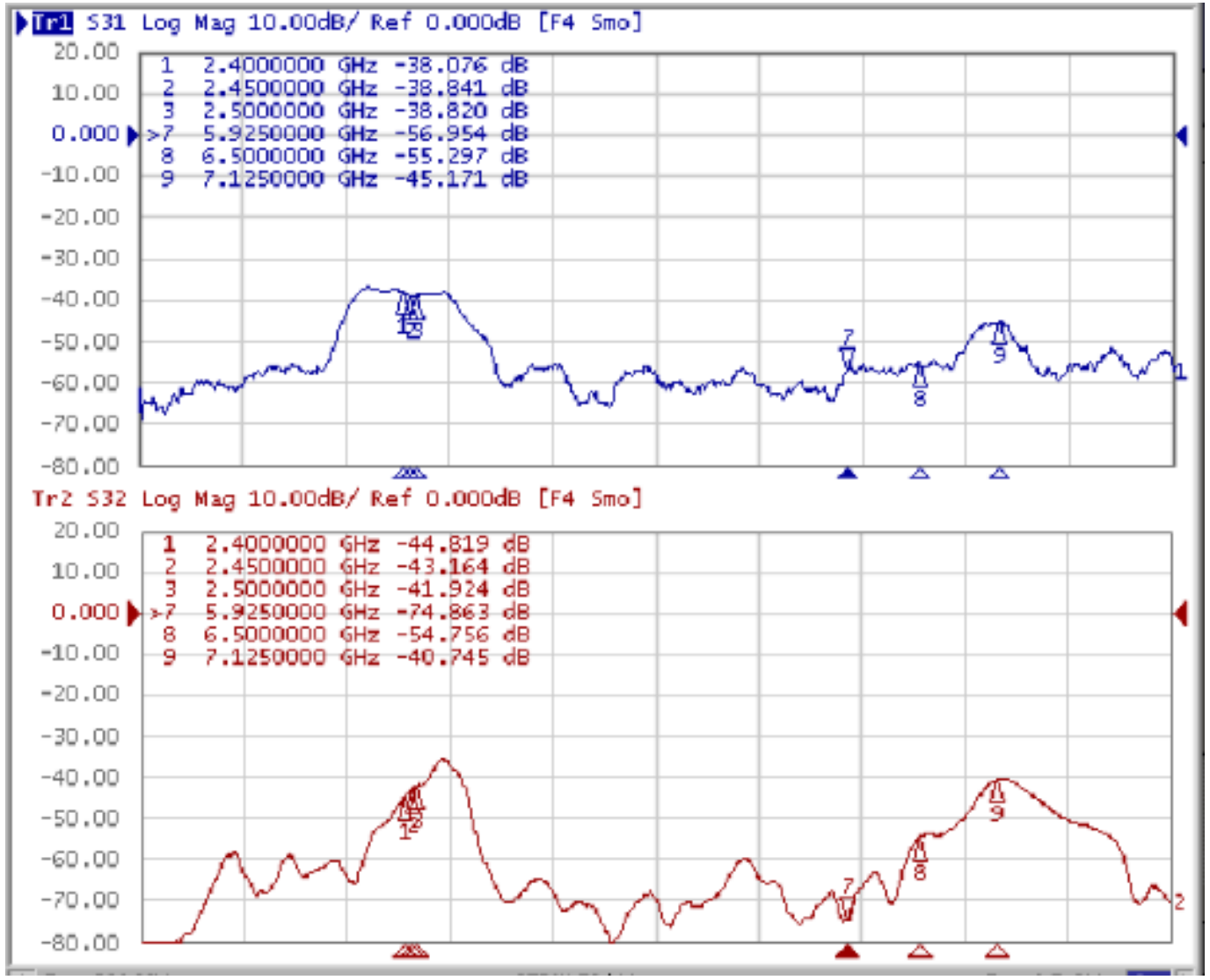
Port1= 6G0

Port2= 6G1

Port3= BT



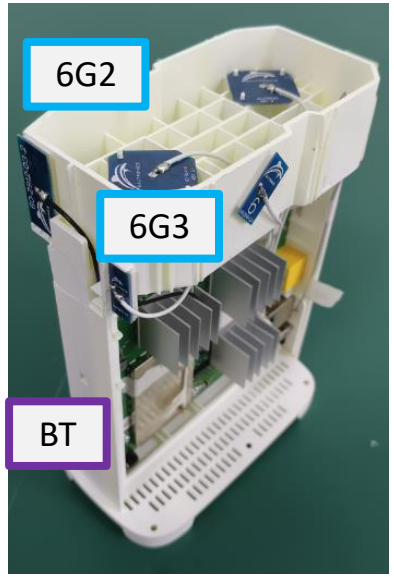
Antenna Isolation of the 6G and BT



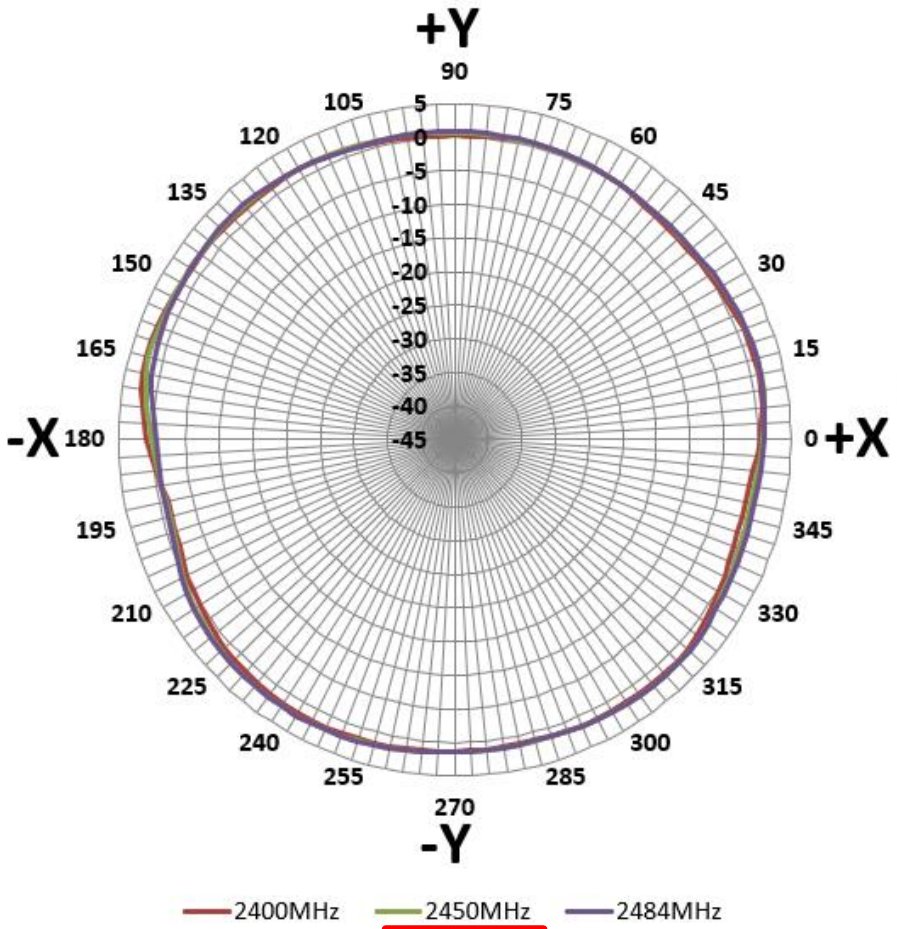
Port1= 6G2

Port2= 6G3

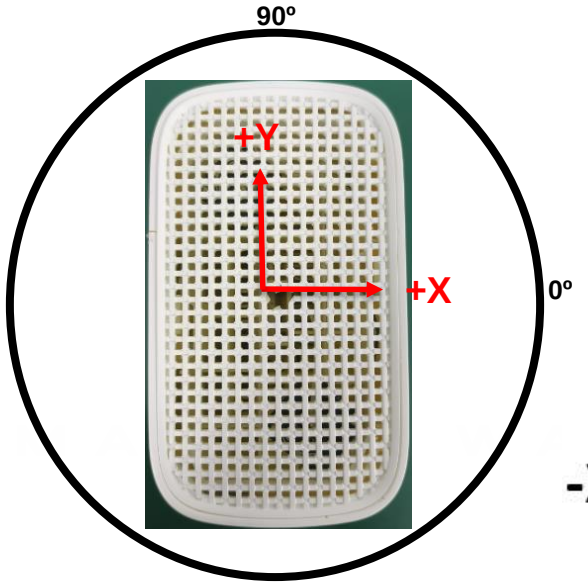
Port3= BT

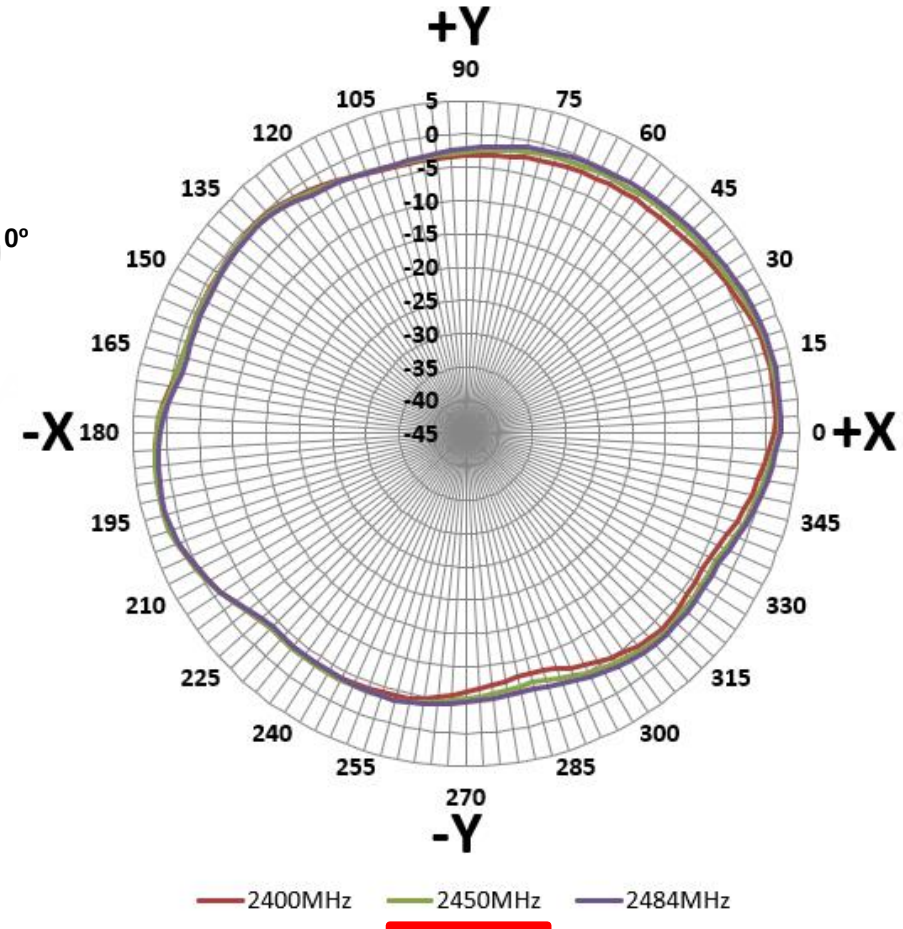


Power Sum-2.4GHz Band-Azimuth(XY)



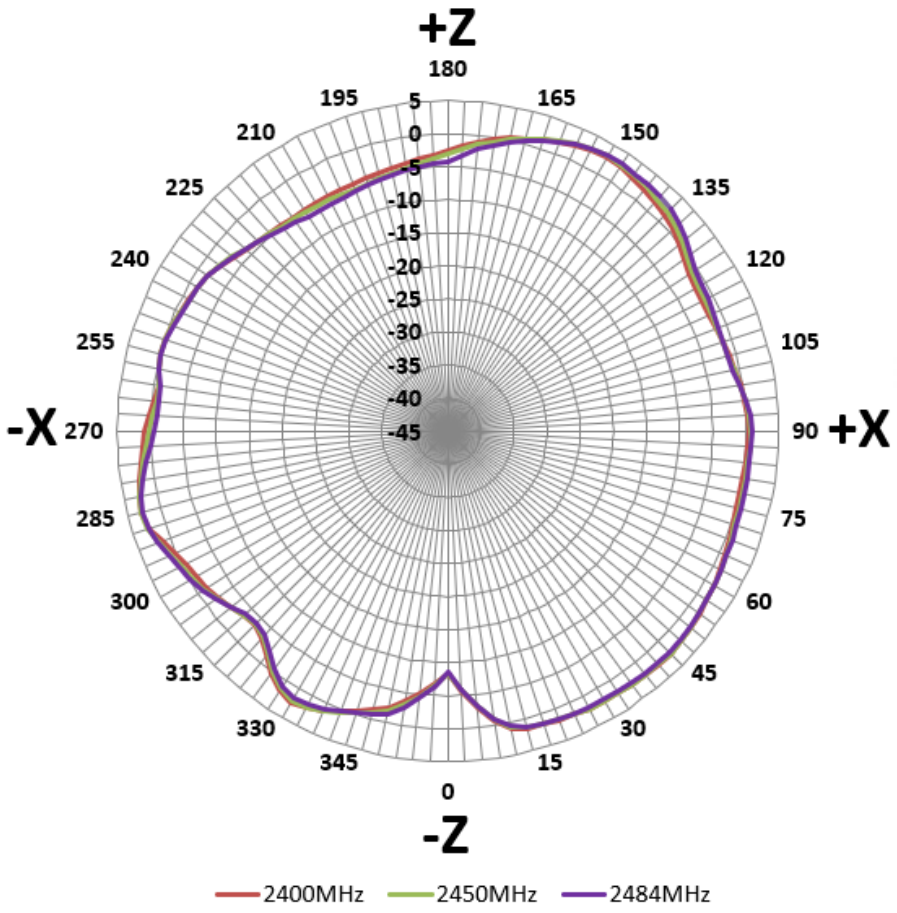
2G0



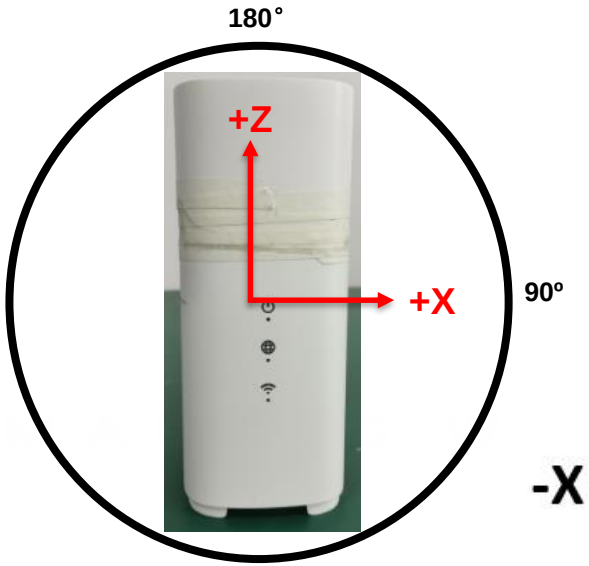


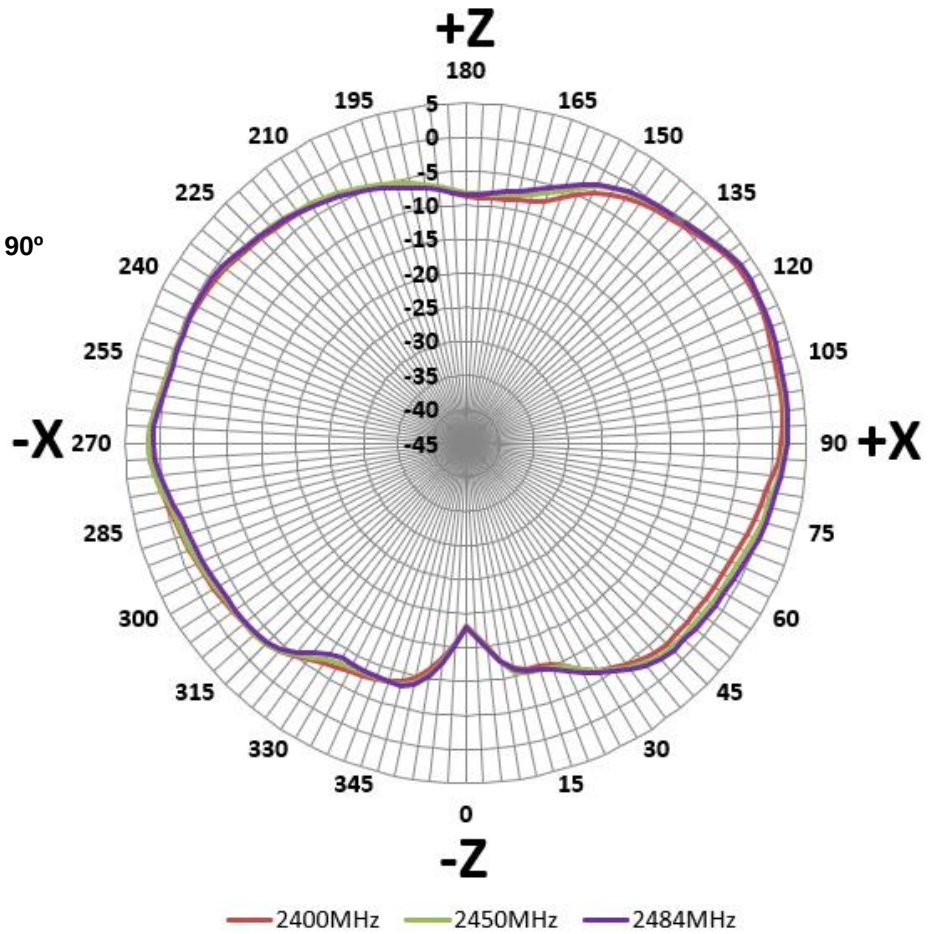
2G1

Power Sum-2.4GHz Band-Elevation Cut (ZX)



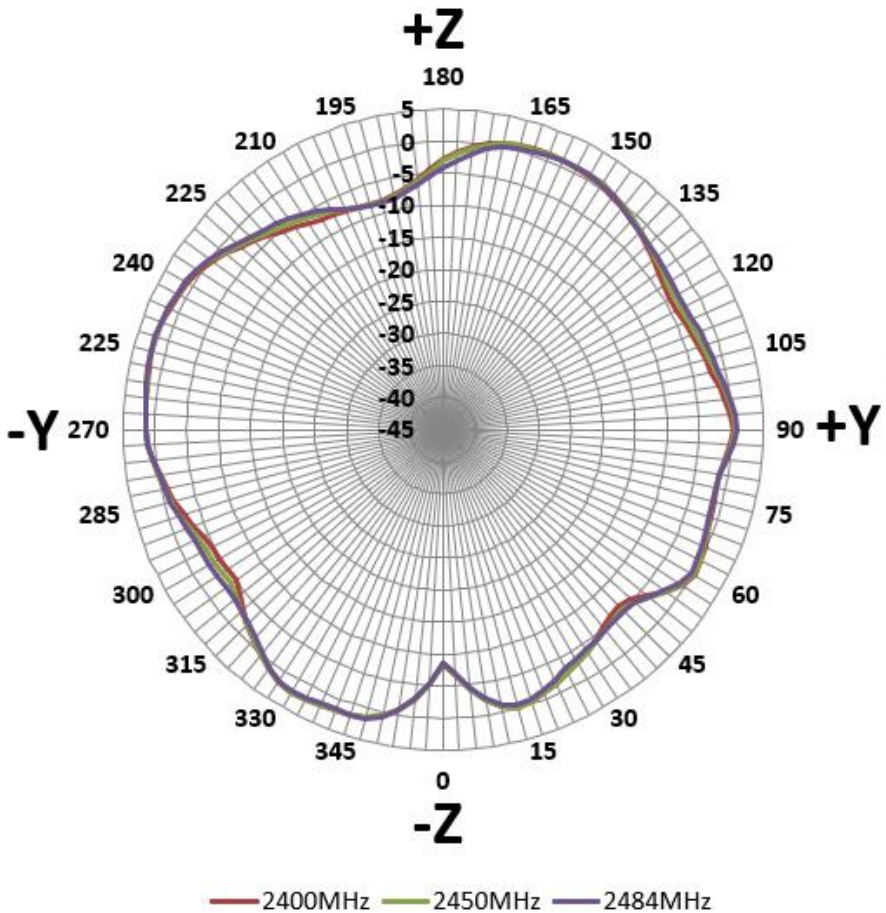
2G0



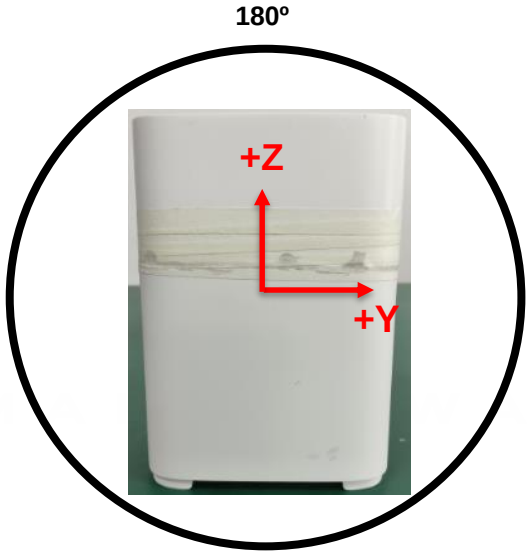


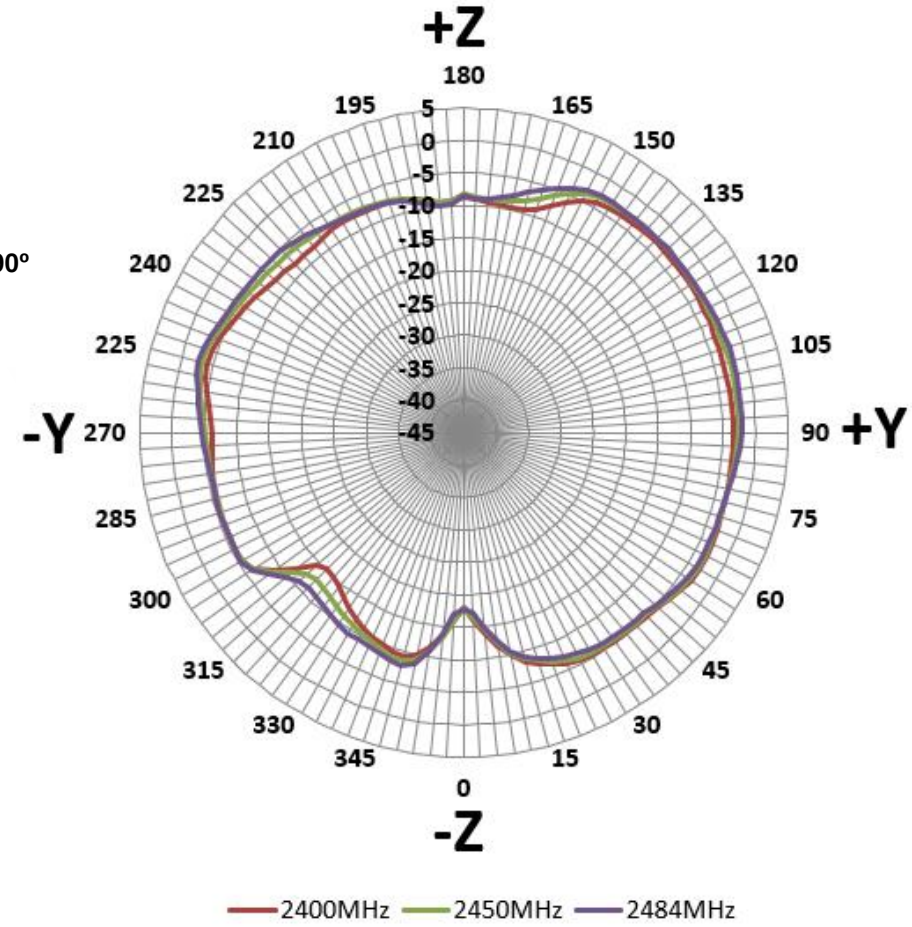
2G1

Power Sum-2.4GHz Band-Elevation Cut (ZY)



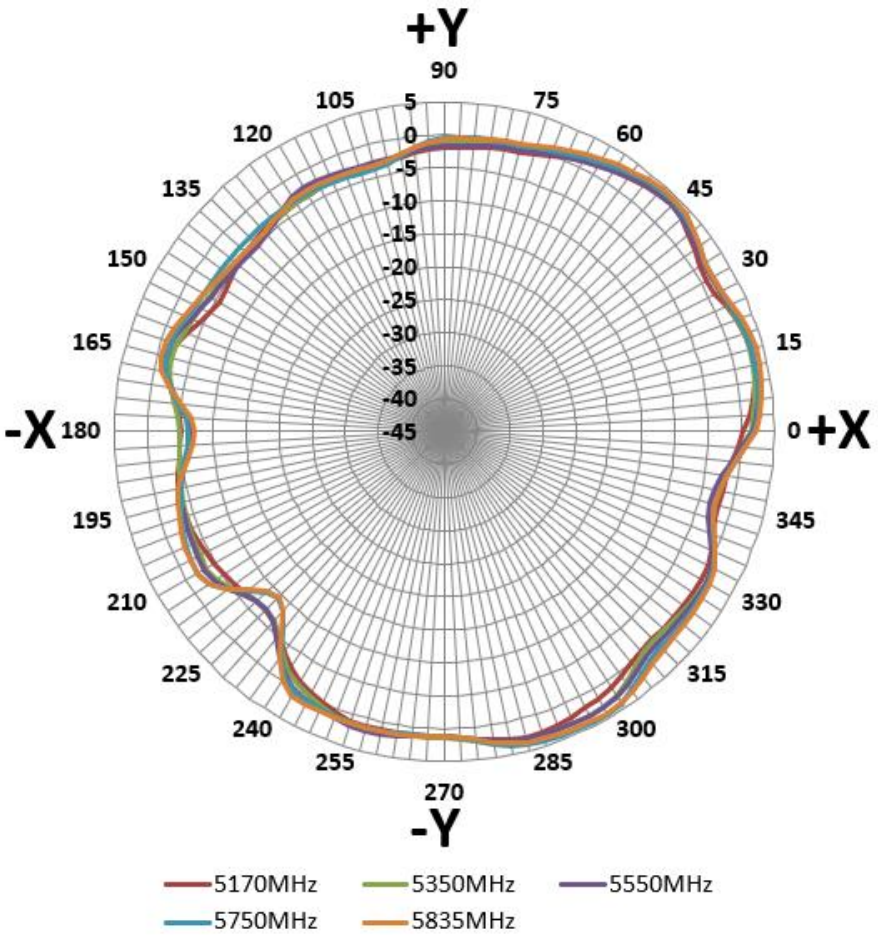
2G0



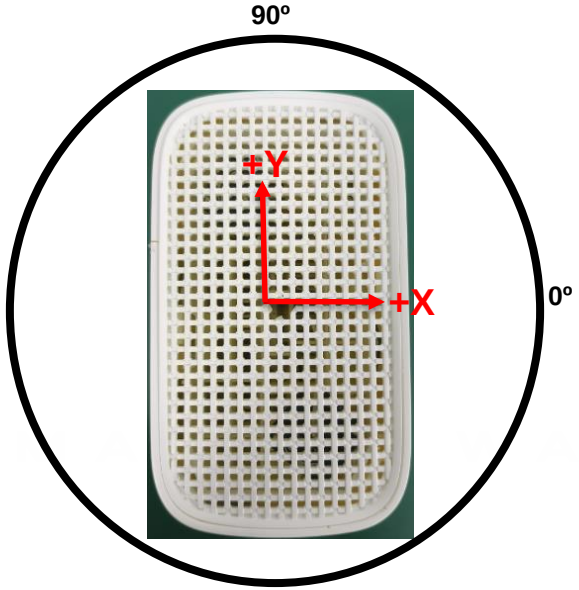


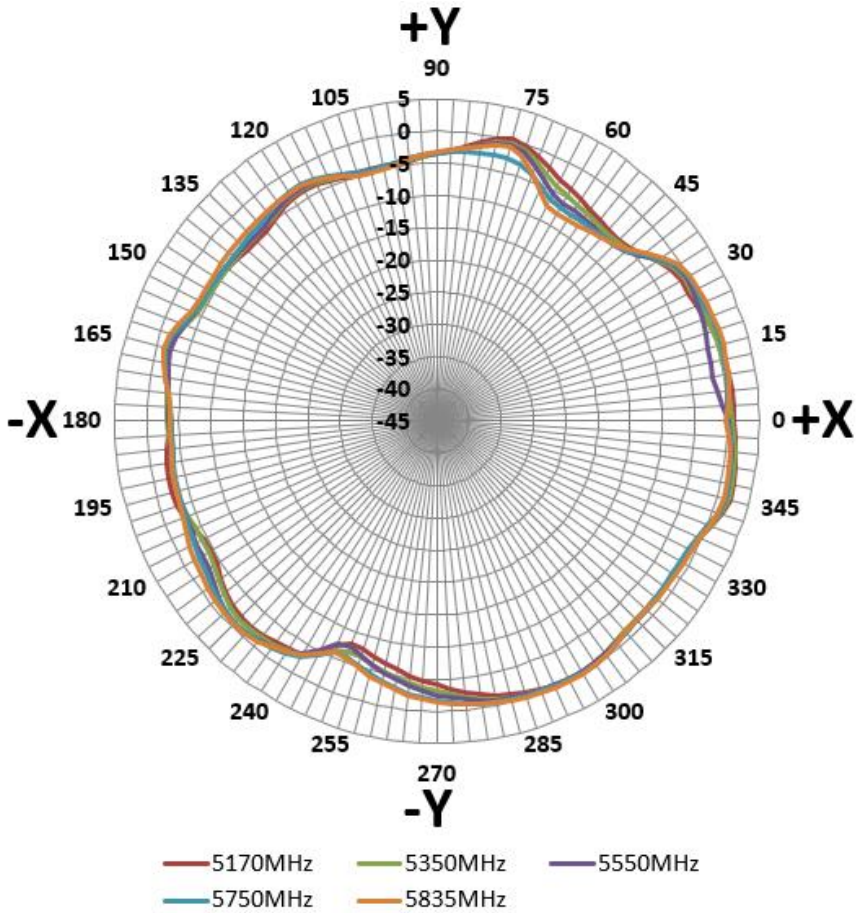
2G1

Power Sum-5GHz Band-Azimuth(XY)



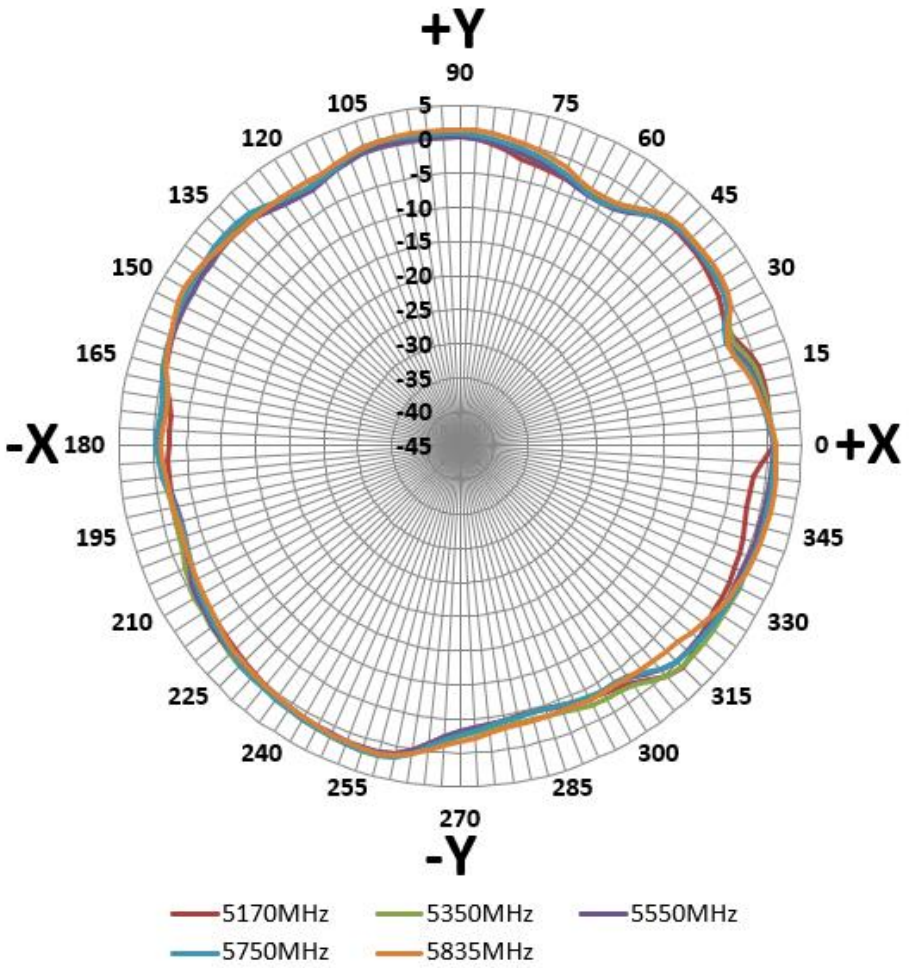
5G0



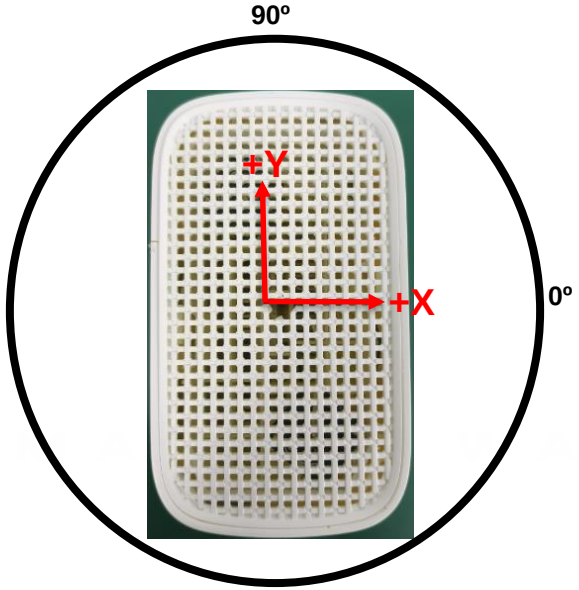


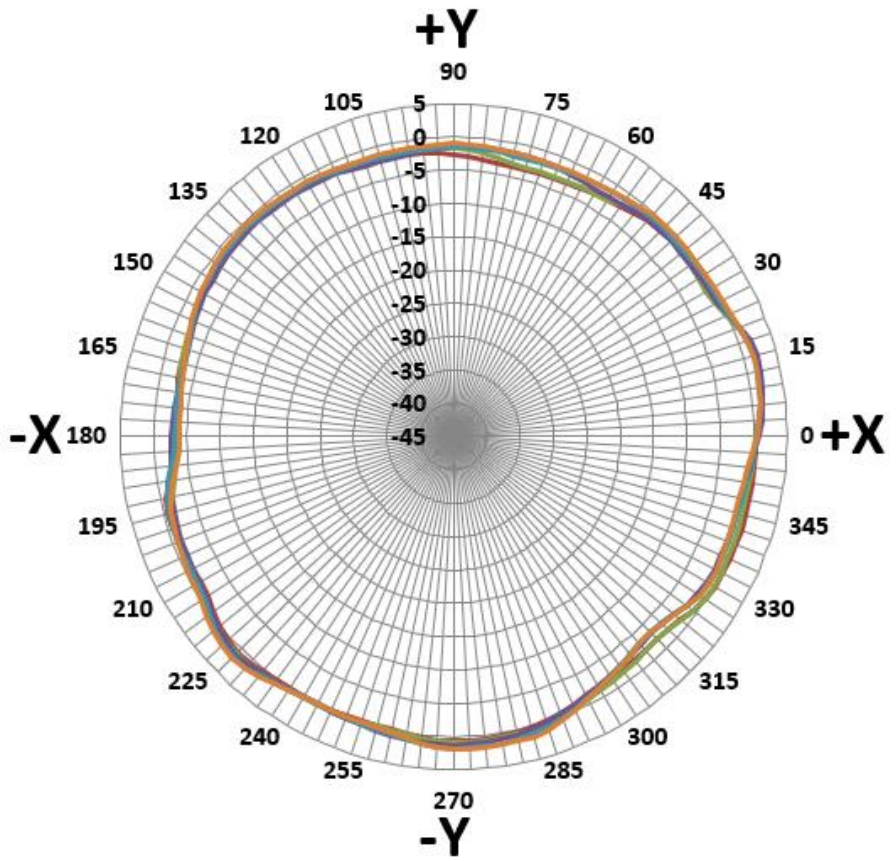
5G1

Power Sum-5GHz Band-Azimuth(XY)



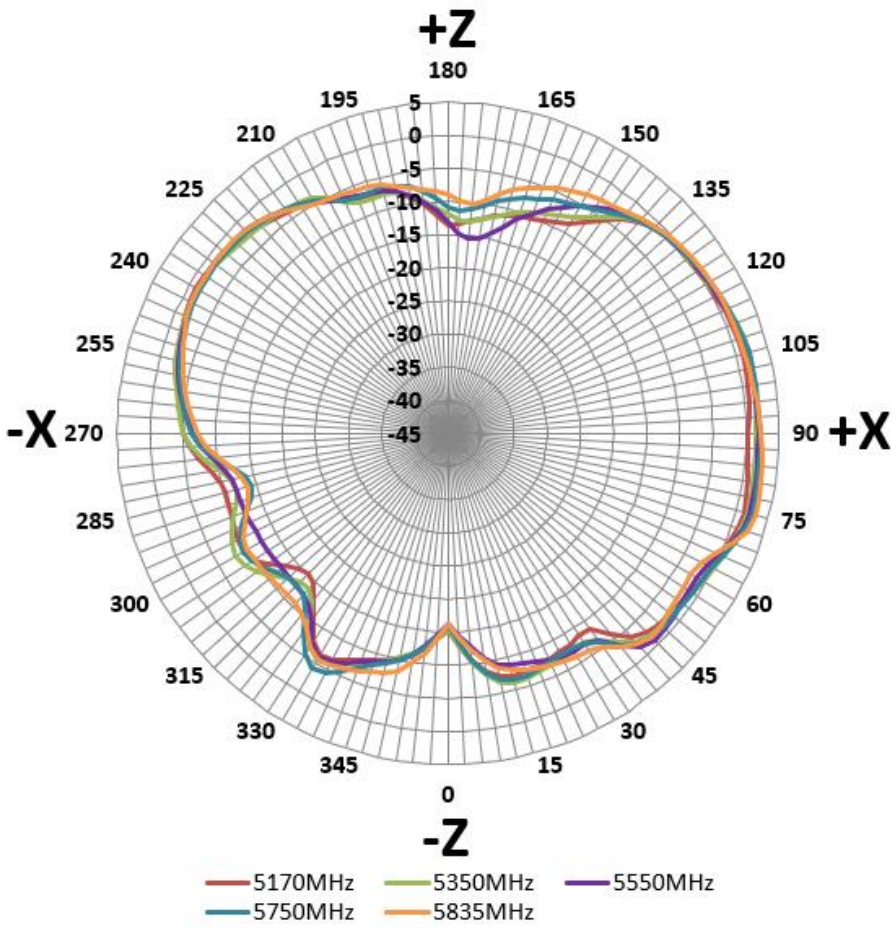
5G2





5G3

Power Sum-5GHz Band-Elevation Cut (ZX)



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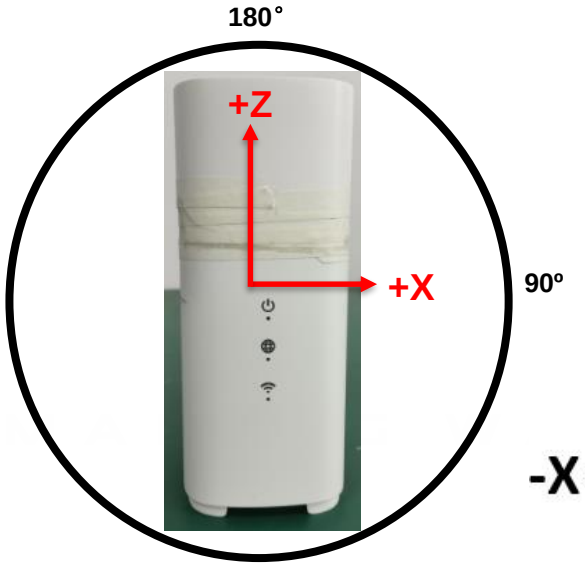
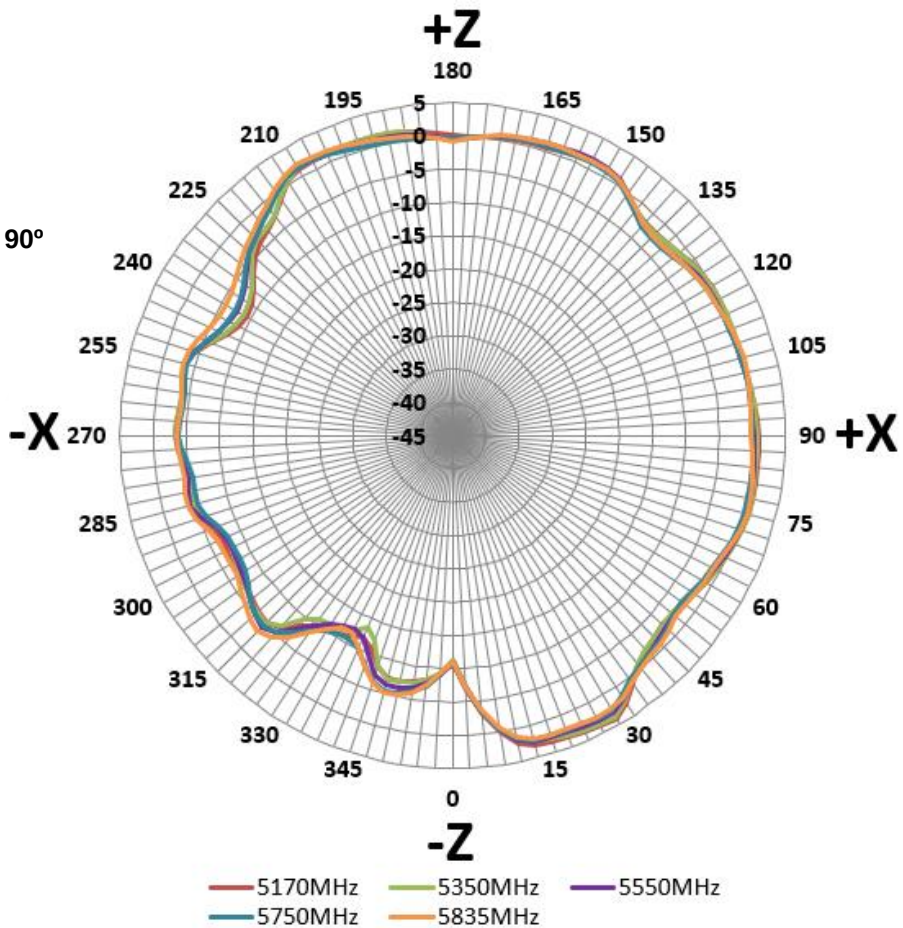
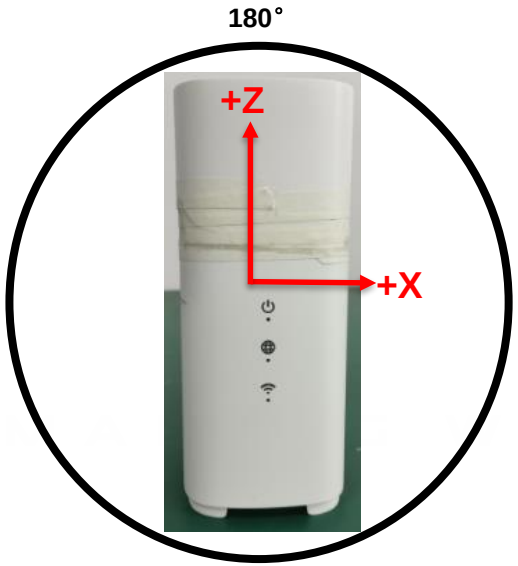
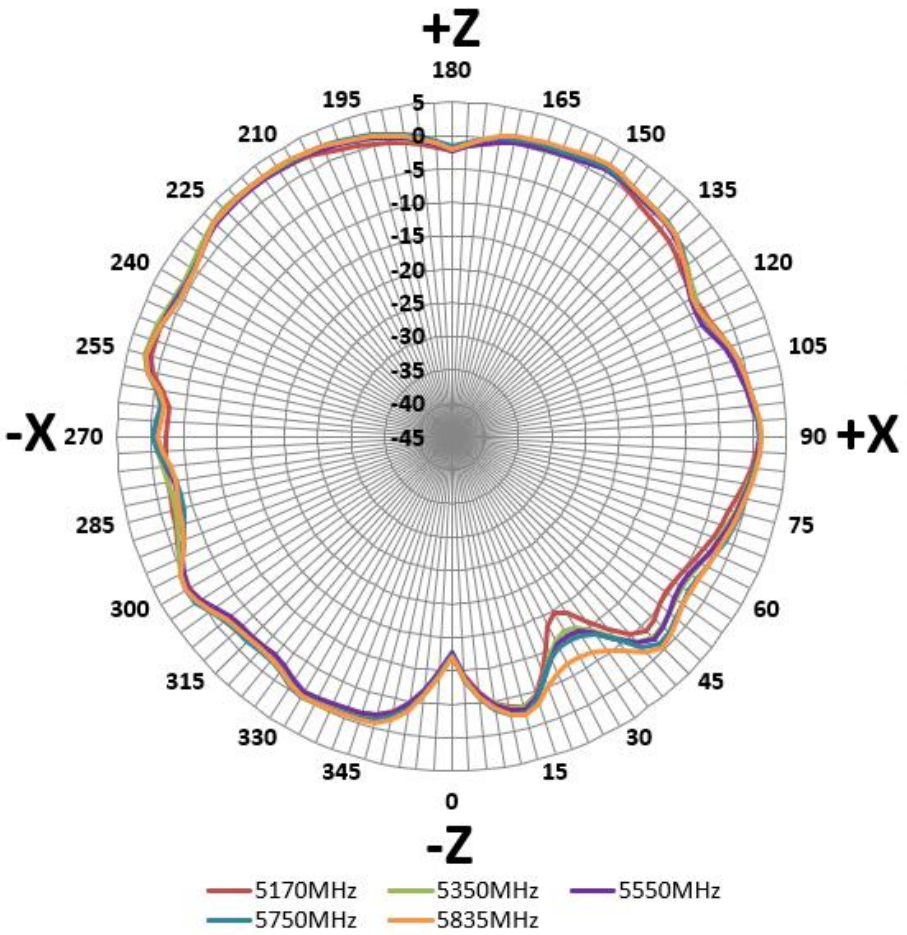




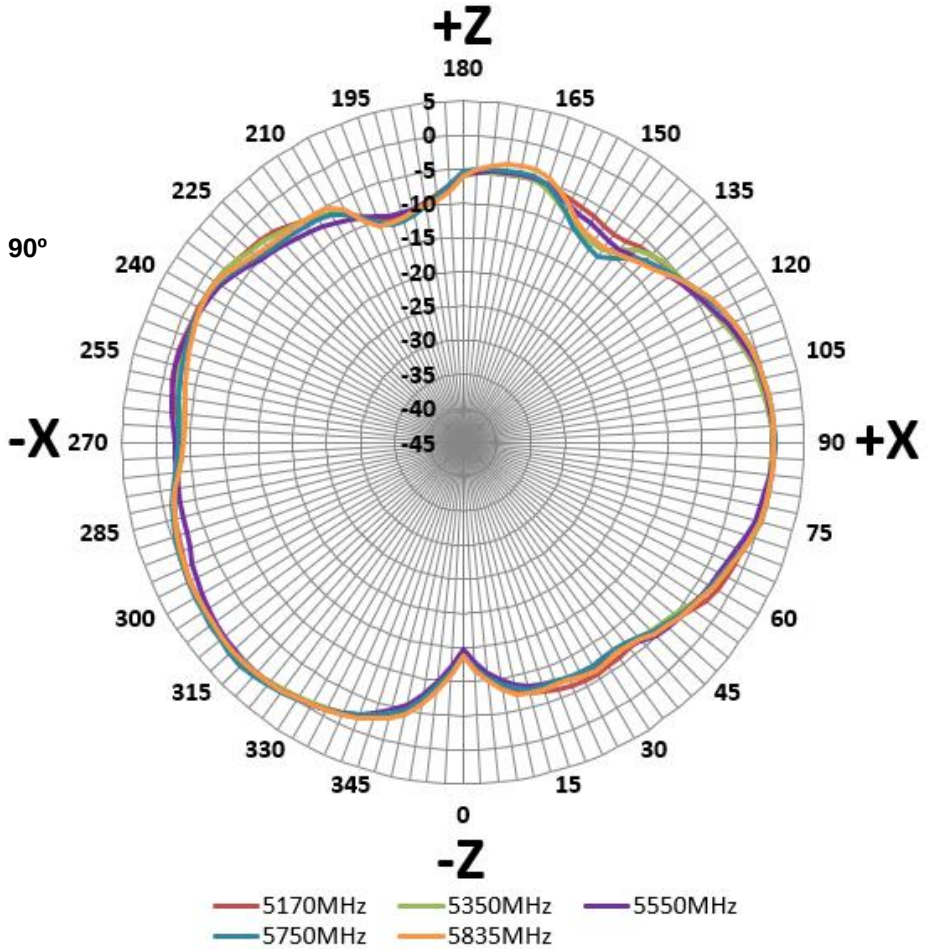
5G1

Power Sum-5GHz Band-
Elevation Cut (ZX)



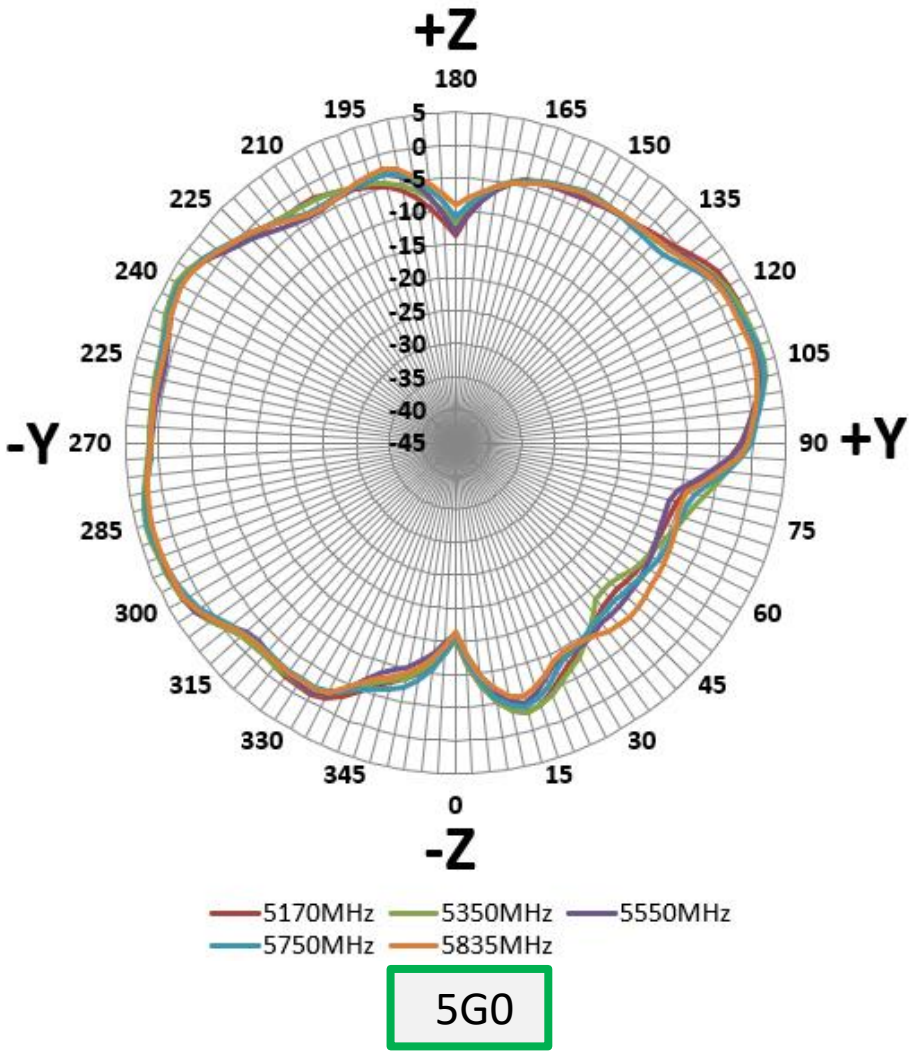


5G2

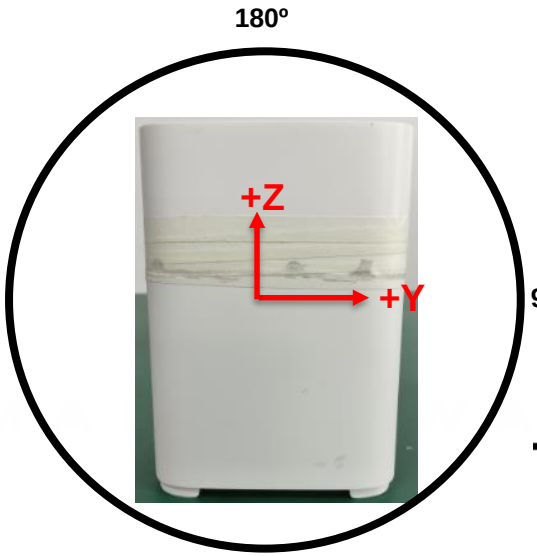


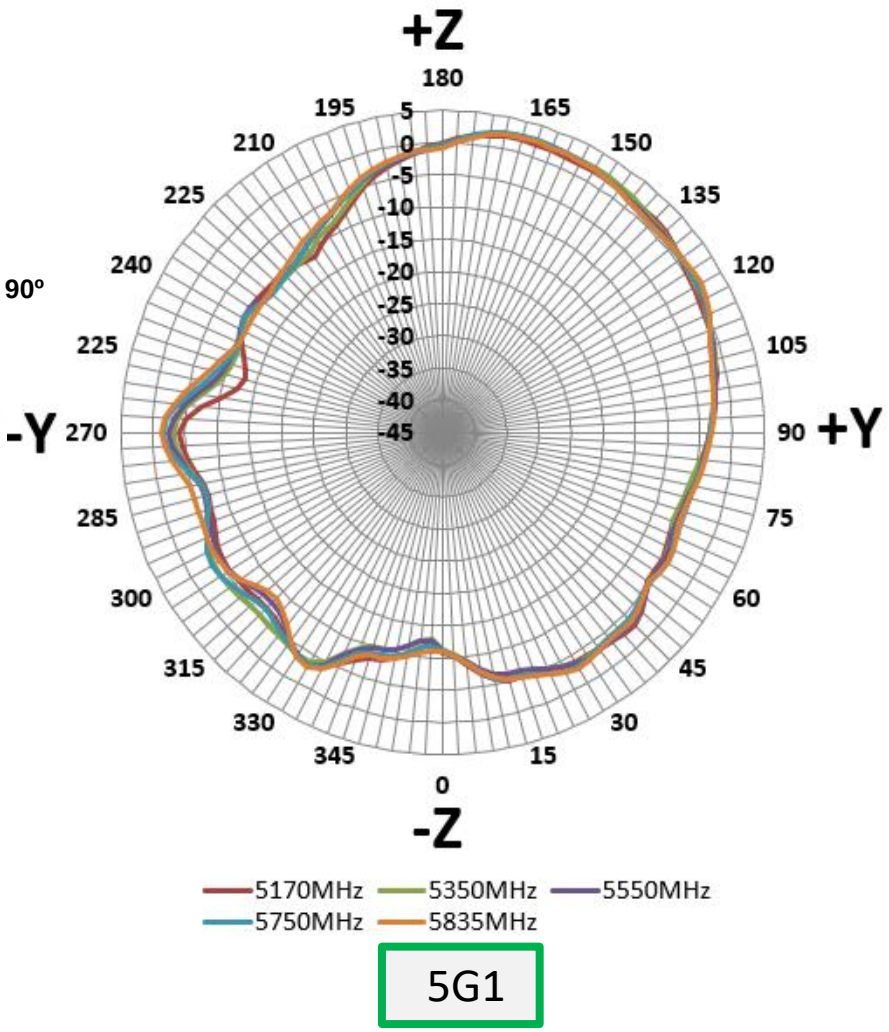
5G3

Power Sum-5GHz Band-
Elevation Cut (ZY)



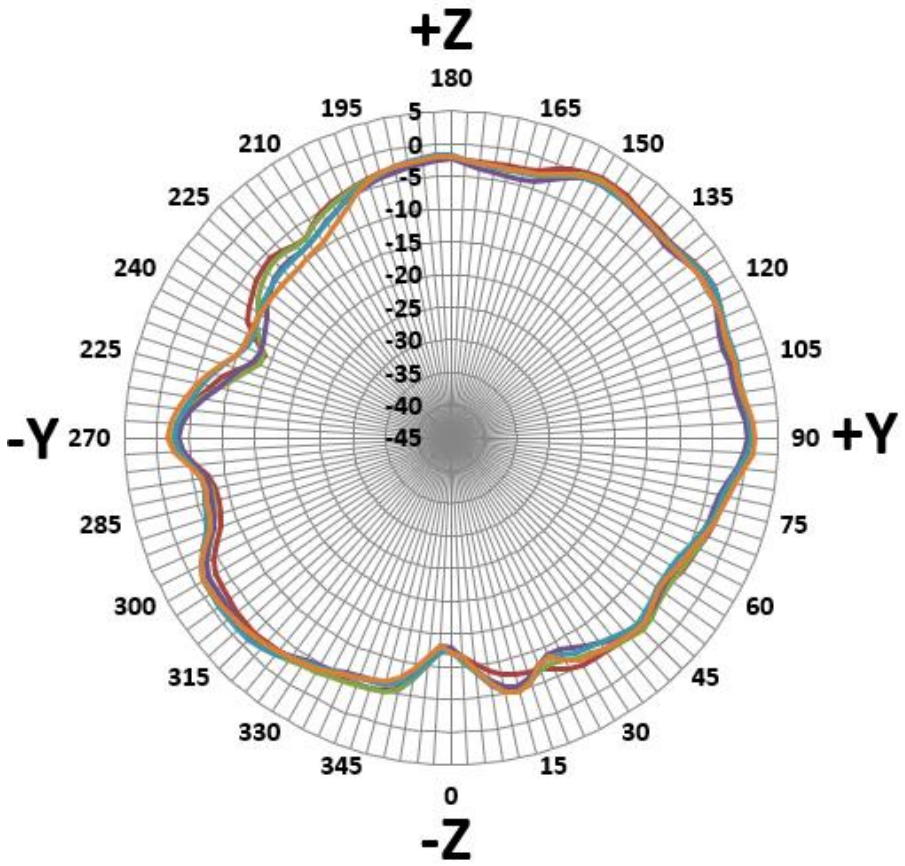
5G0





5G1

Power Sum-5GHz Band-
Elevation Cut (ZY)



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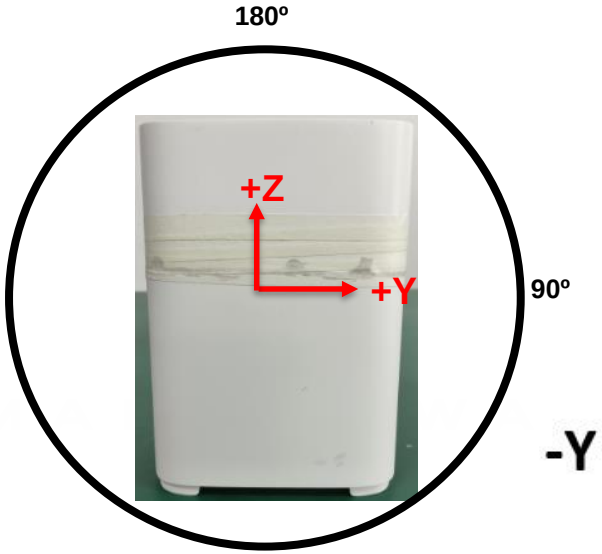
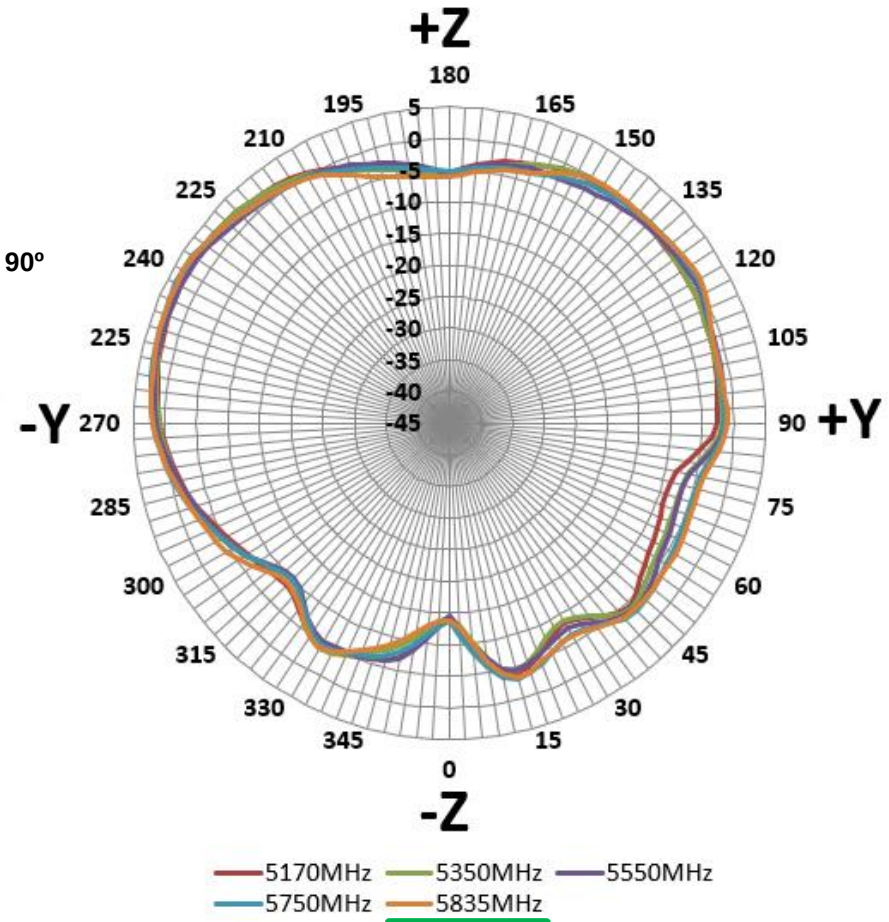
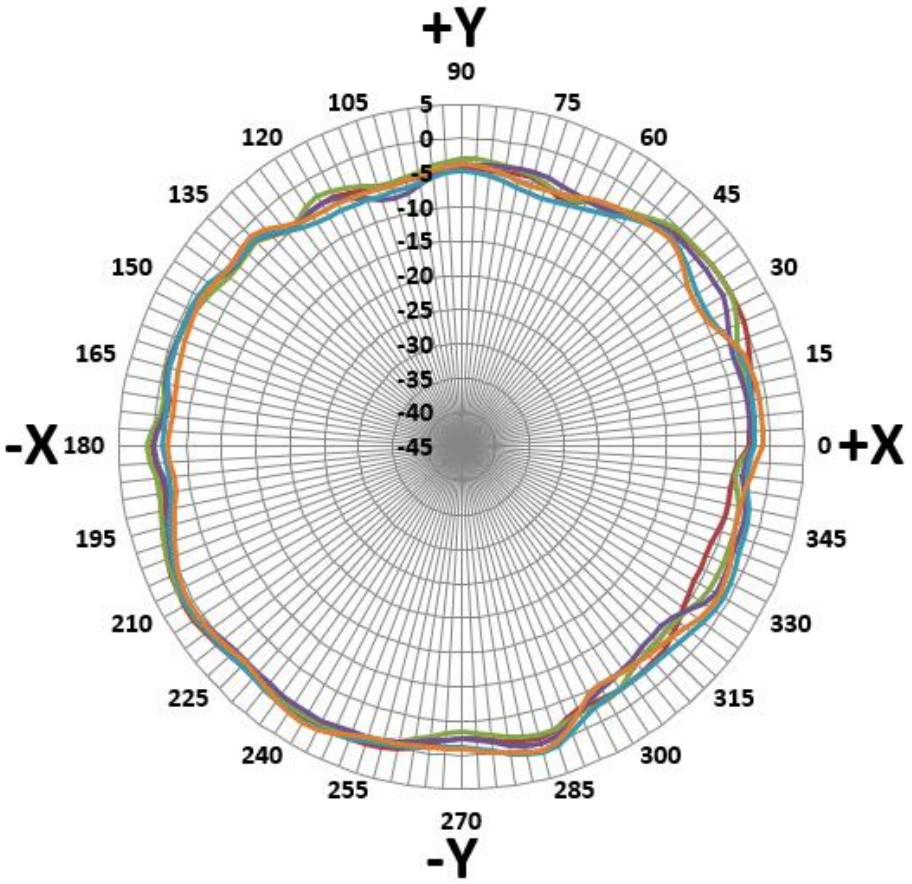


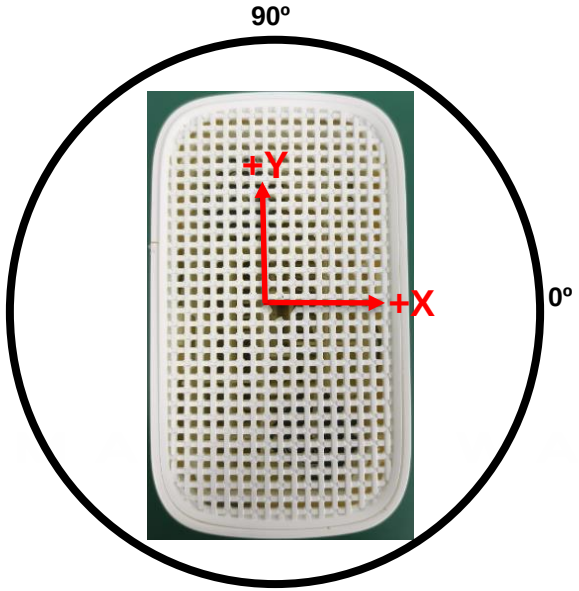


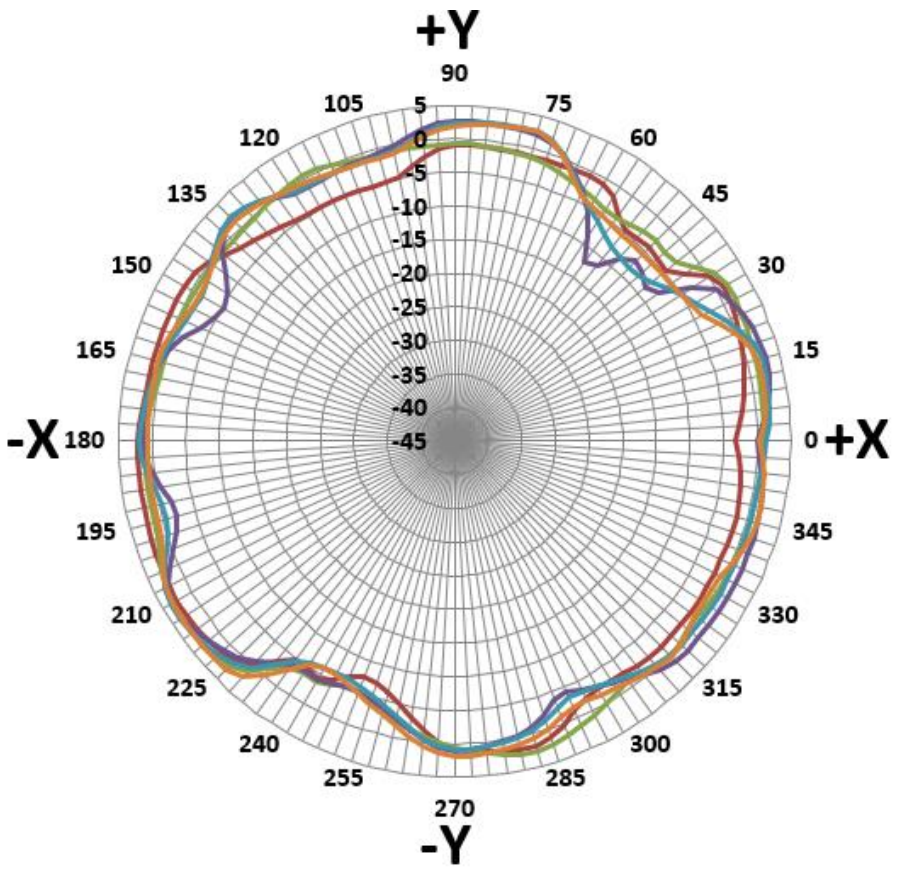
5G3

Power Sum-6GHz Band-Azimuth(XY)



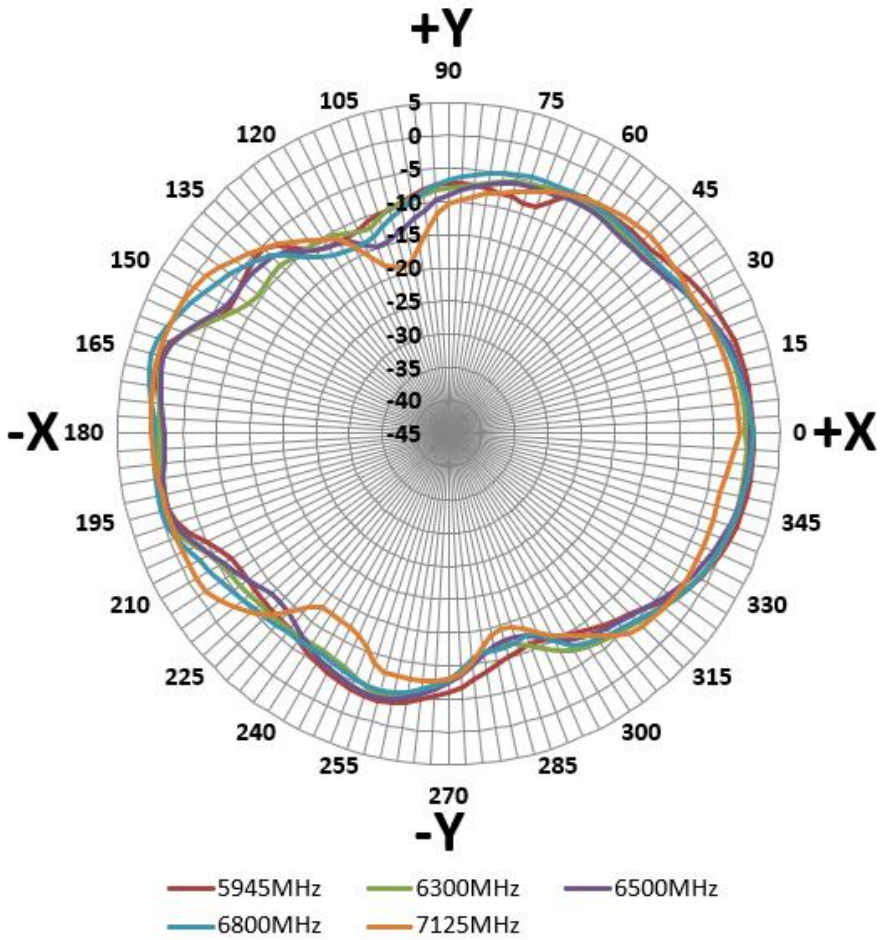
6G0





6G1

Power Sum-6GHz Band-Azimuth(XY)



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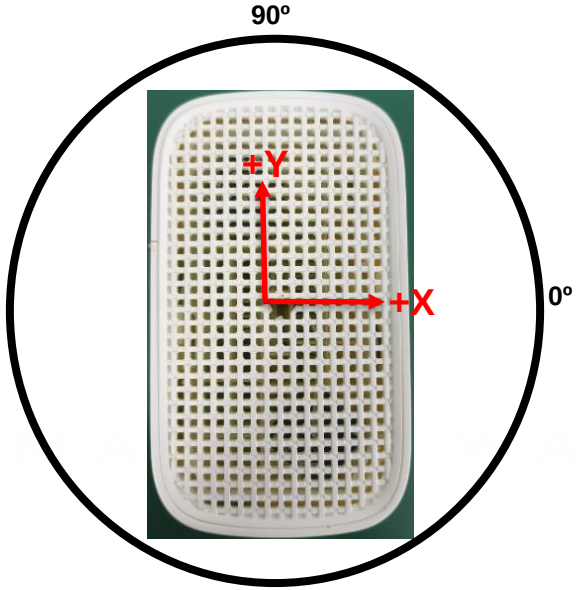
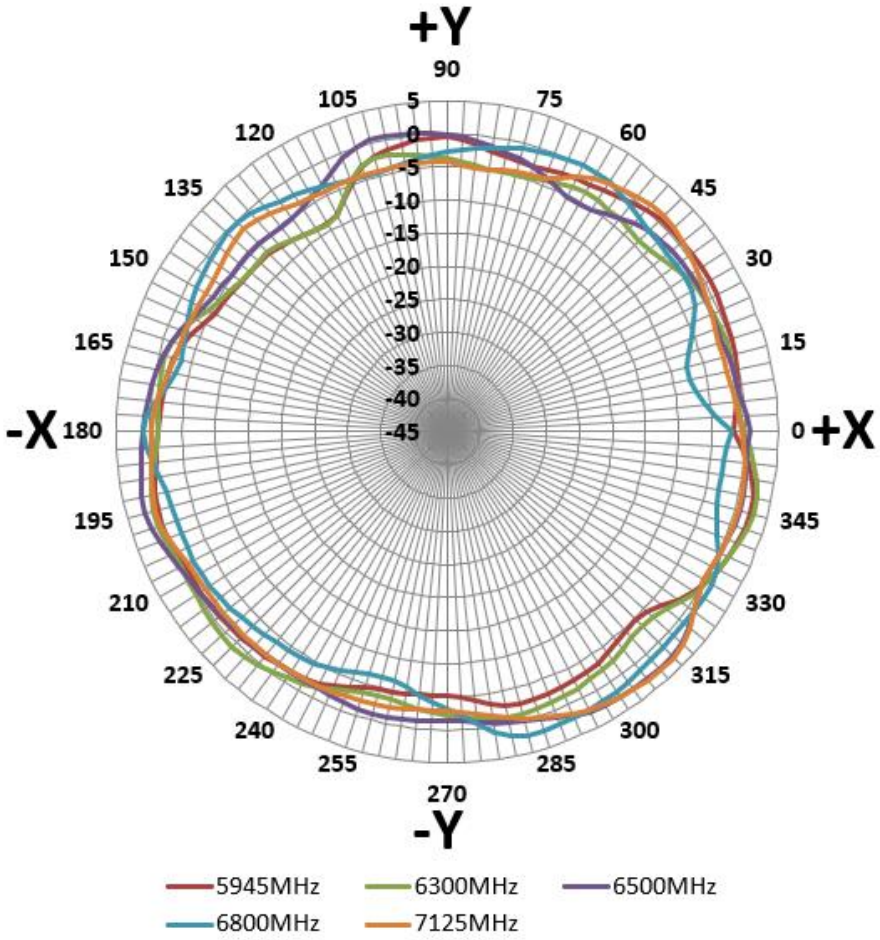
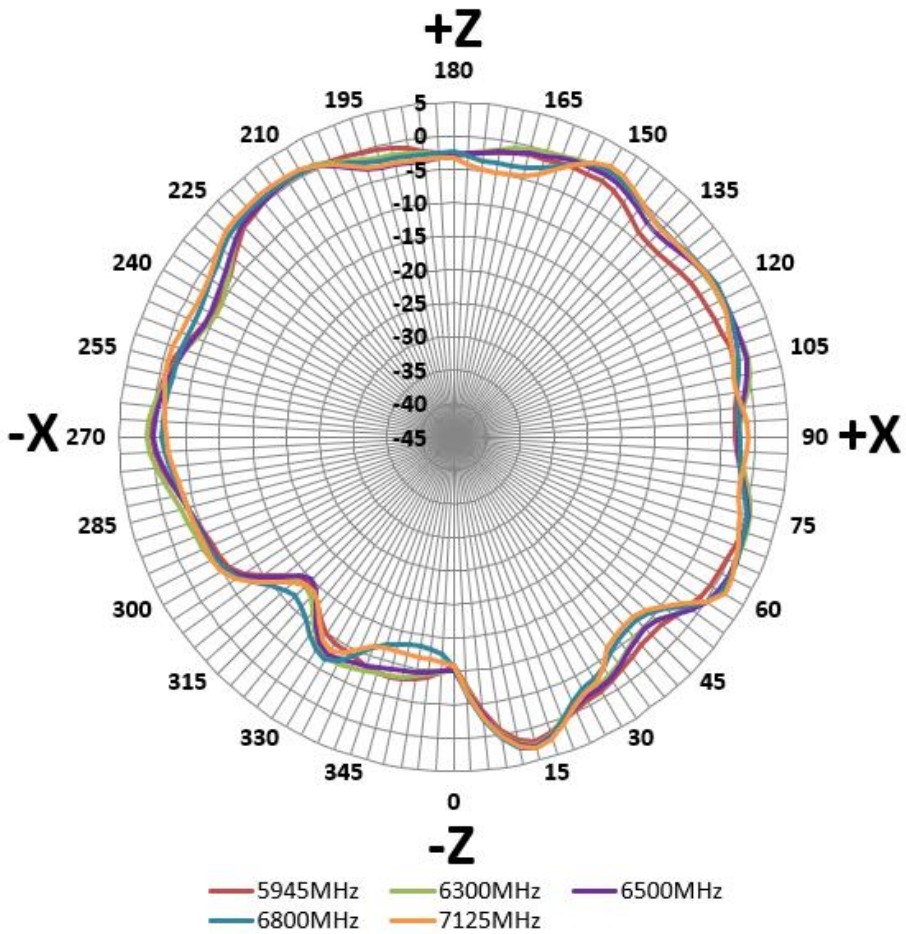


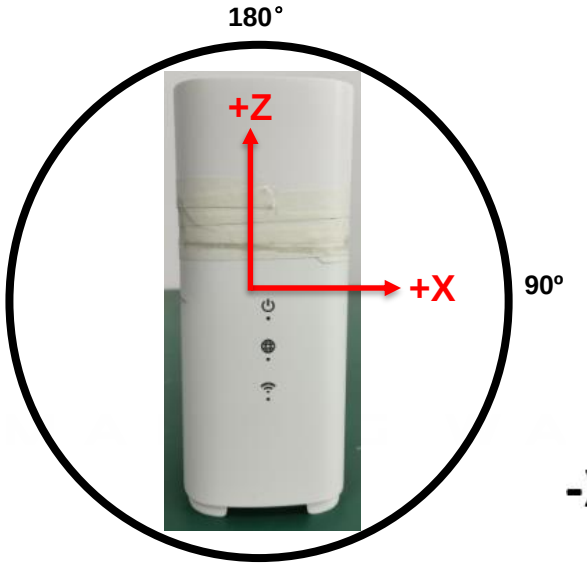


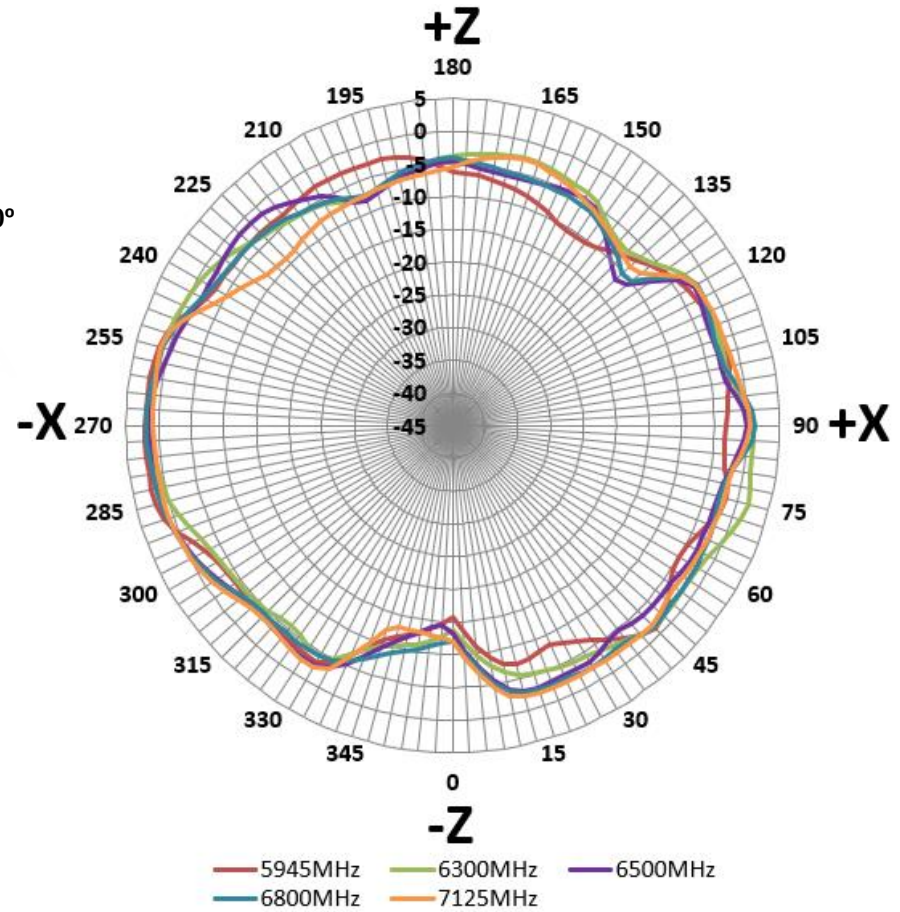
6G3

Power Sum-6GHz Band-Elevation Cut (ZX)



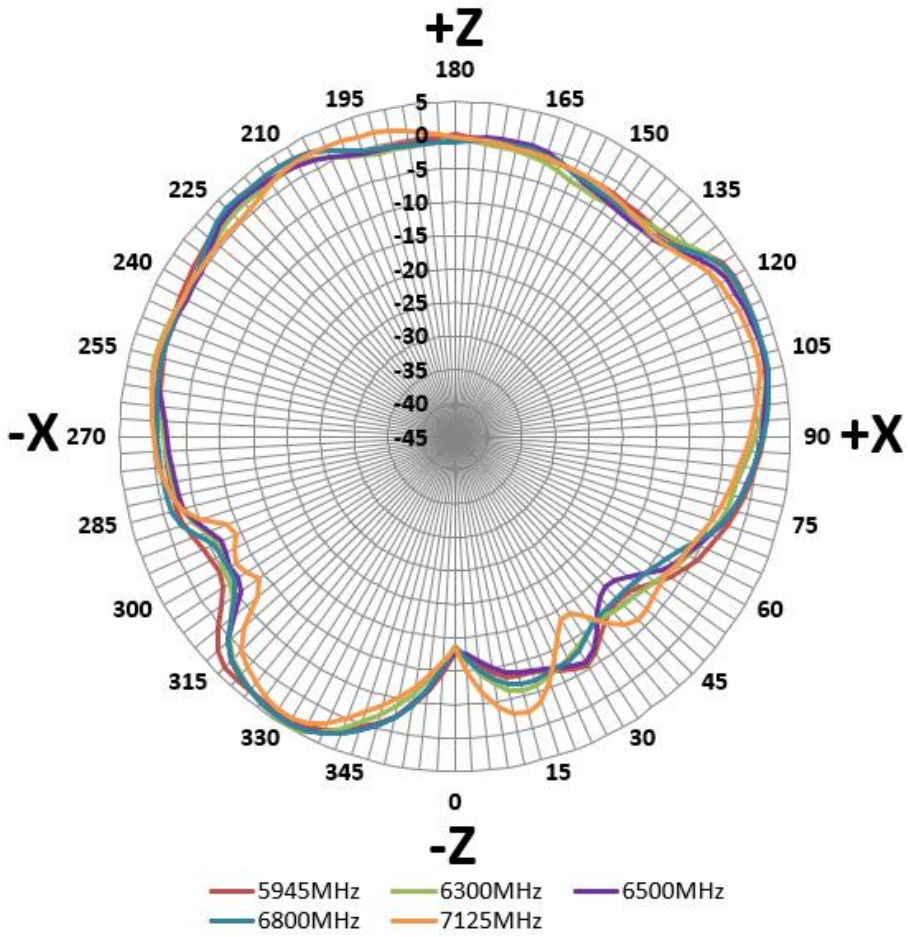
6G0



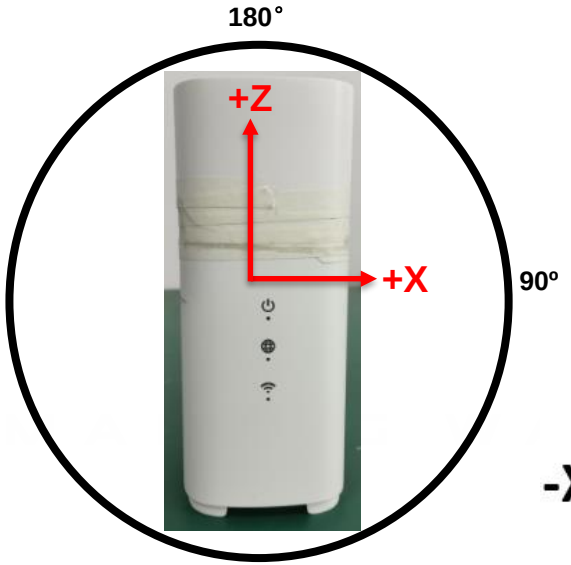


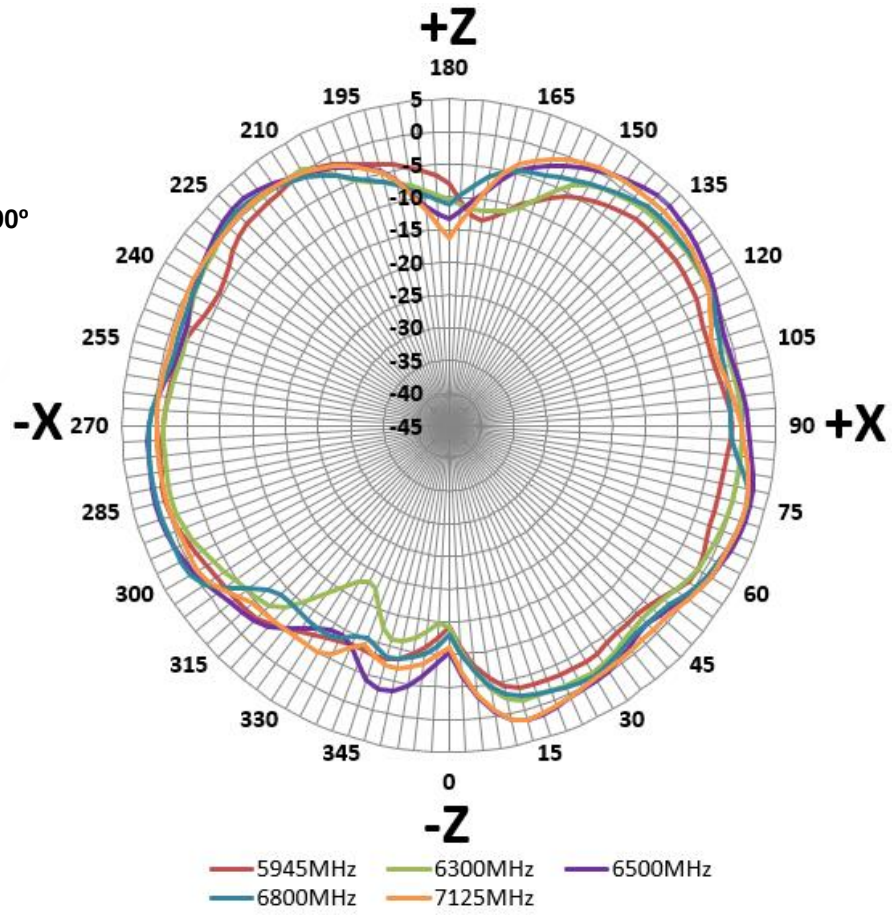
6G1

Power Sum-6GHz Band-Elevation Cut (ZX)



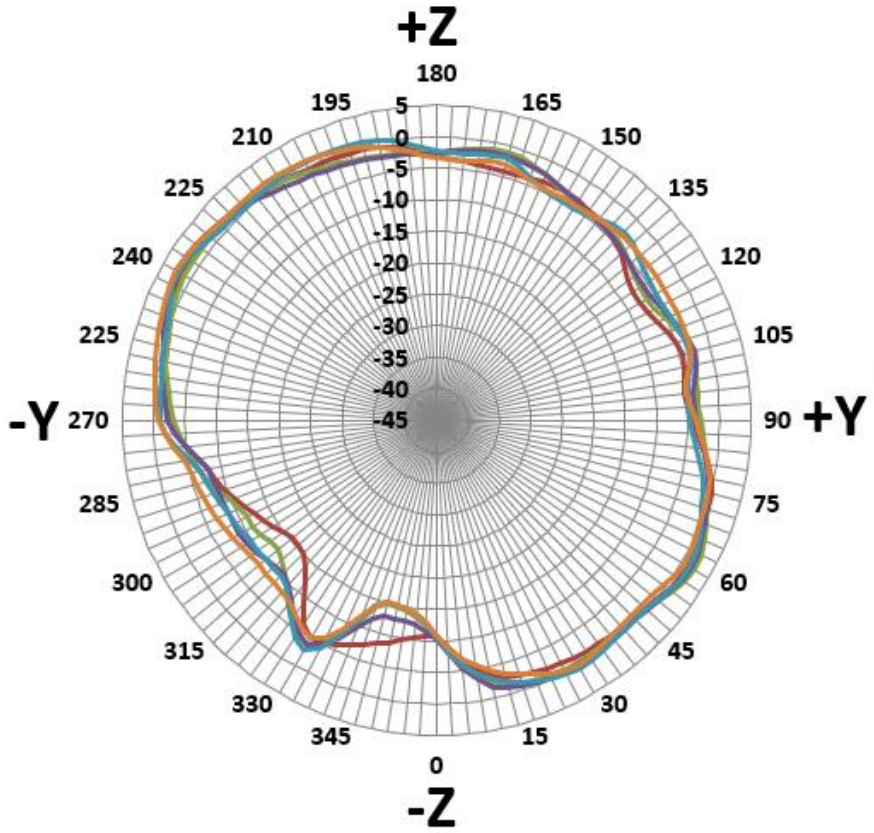
6G2





6G3

Power Sum-6GHz Band-
Elevation Cut (ZY)



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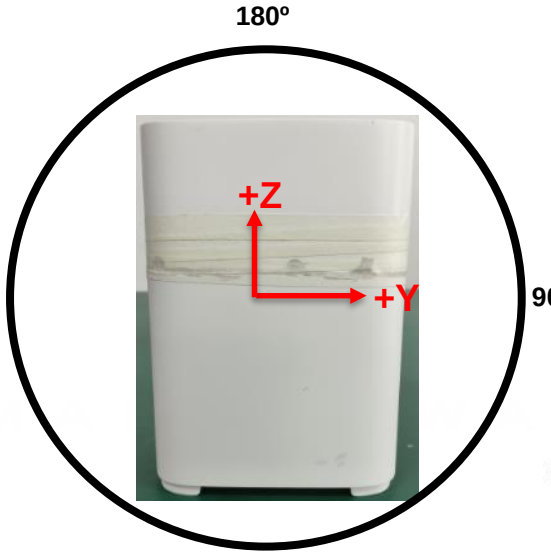
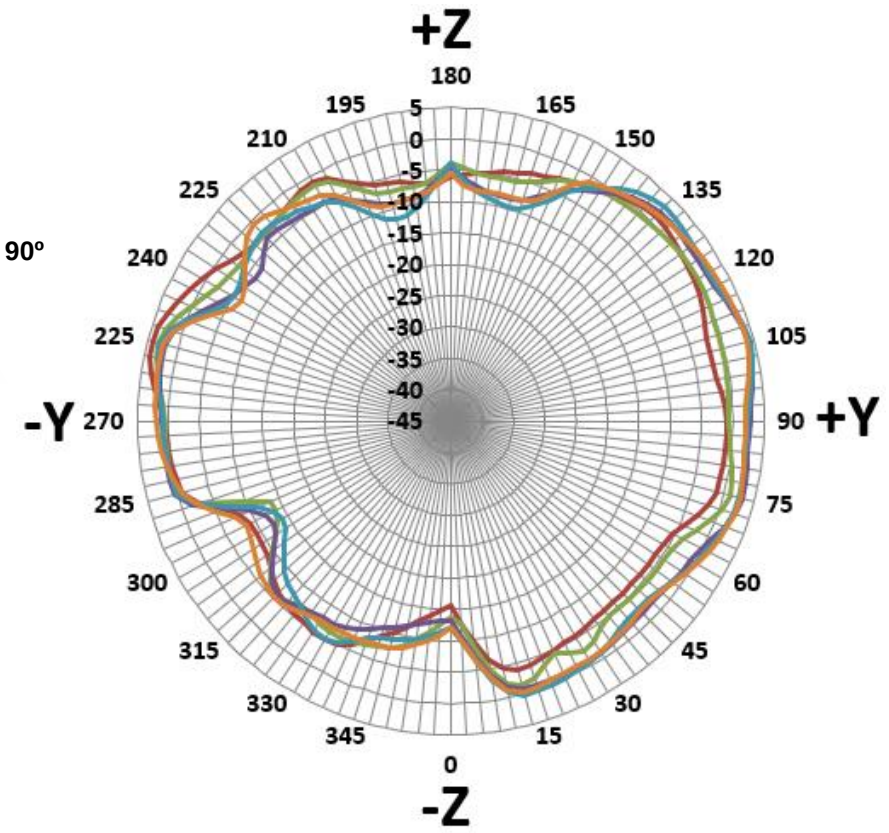
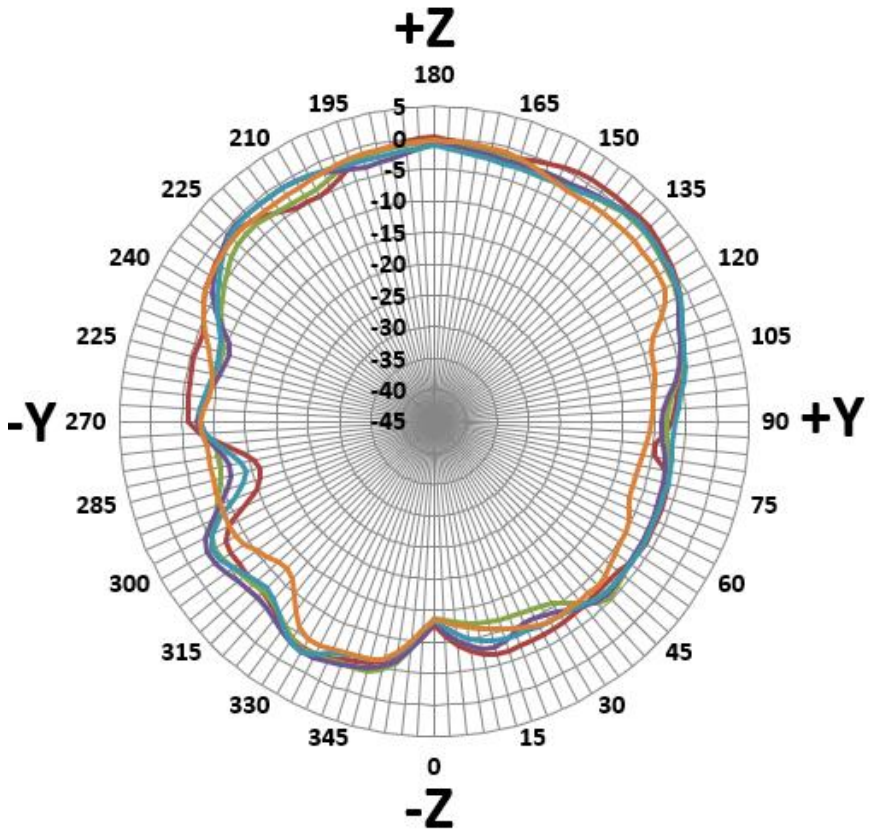


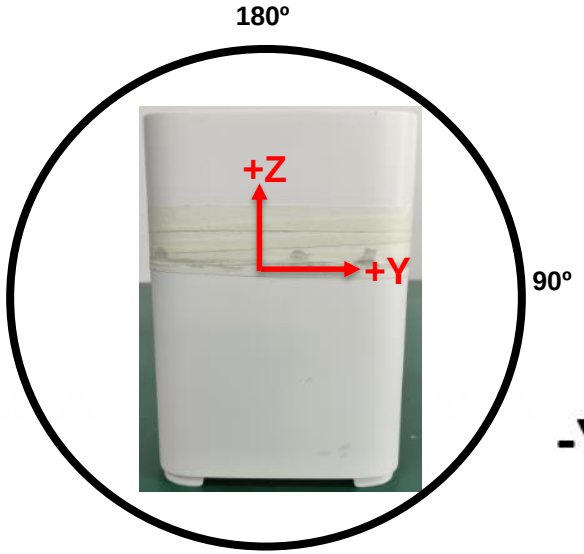


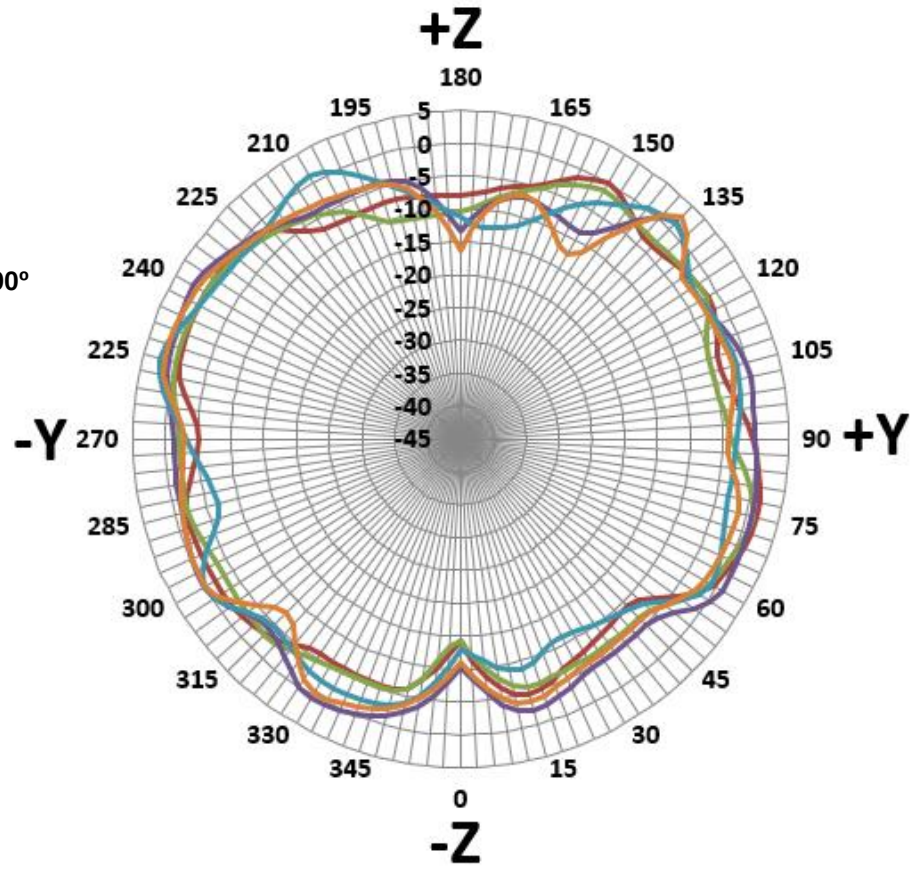
6G1

Power Sum-6GHz Band-Elevation Cut (ZY)



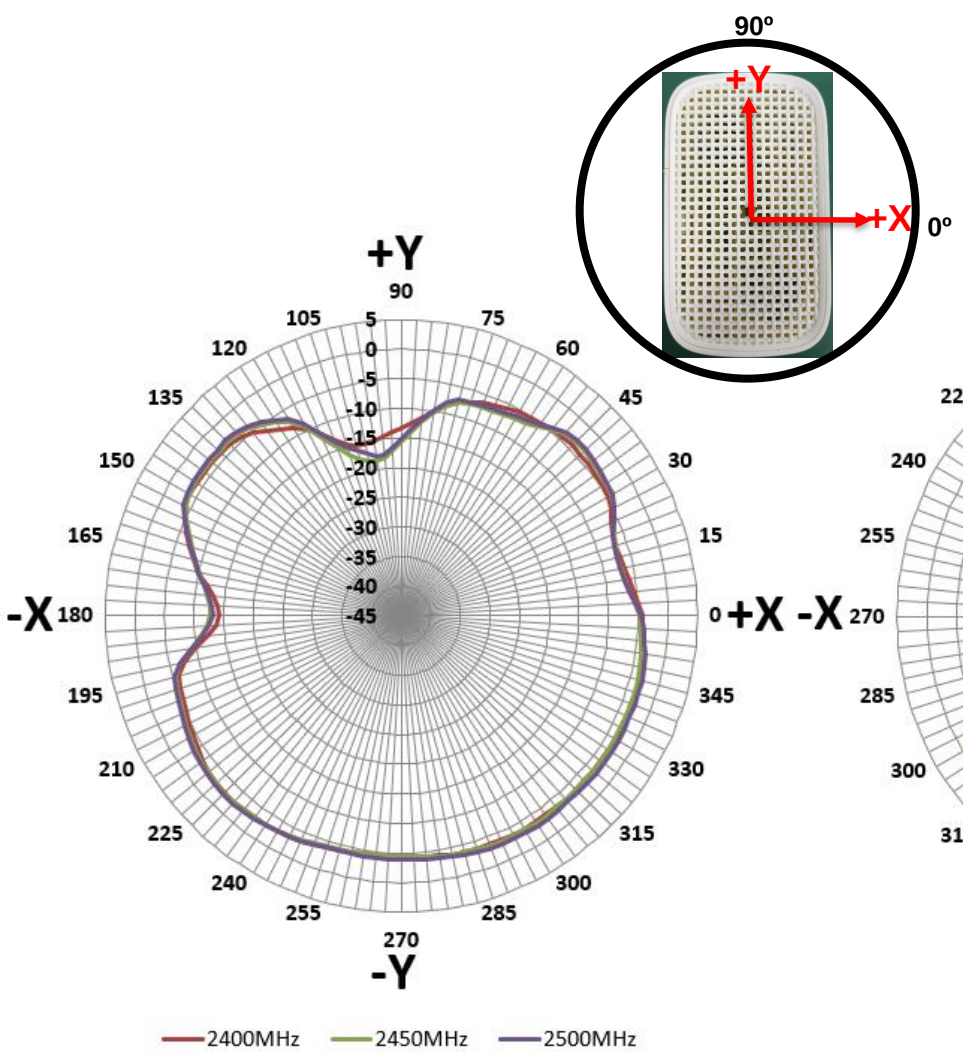
6G2

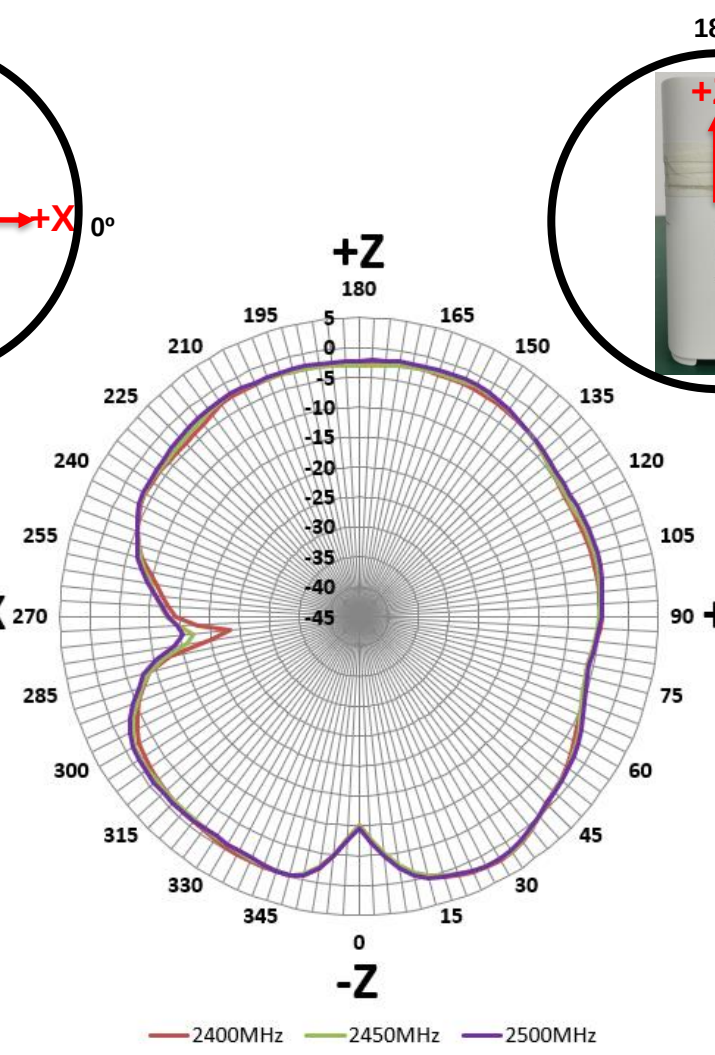


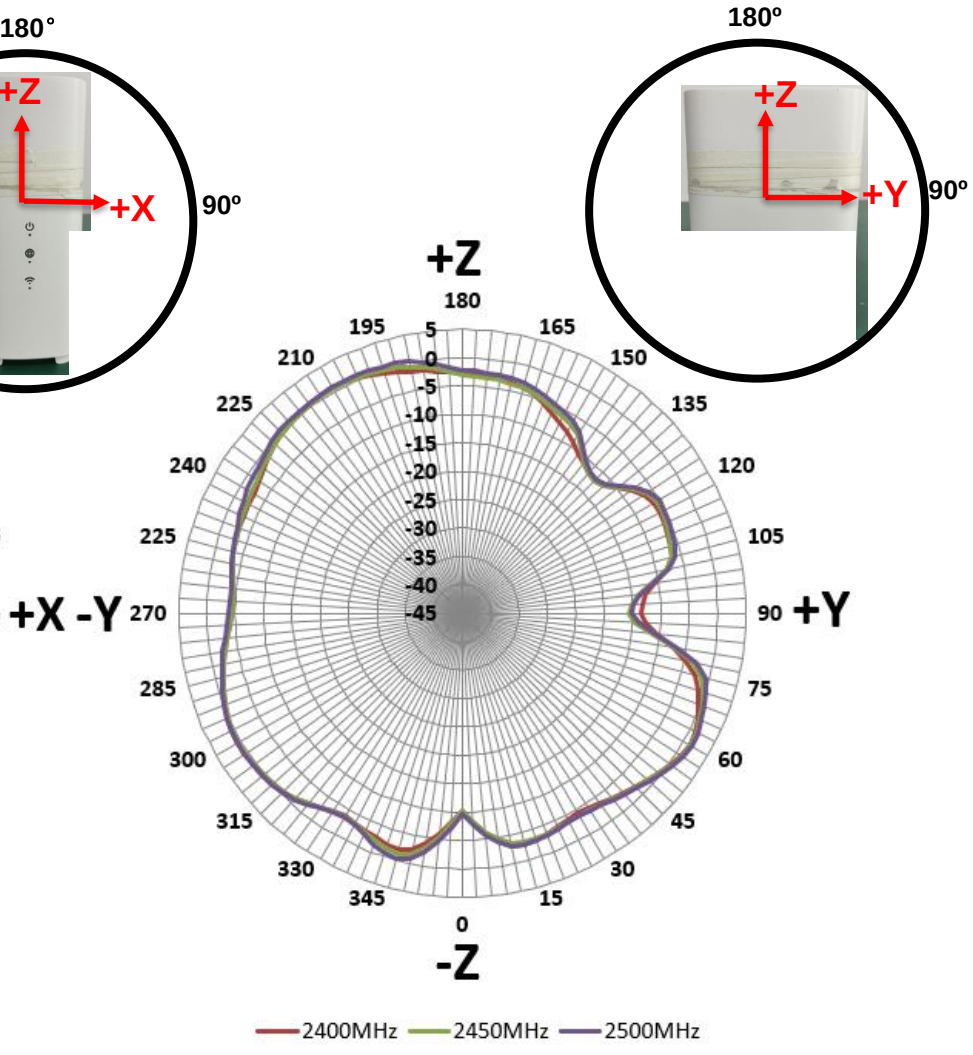


6G3

Power Sum-BT







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Thank You!

We Look Forward To Working Together