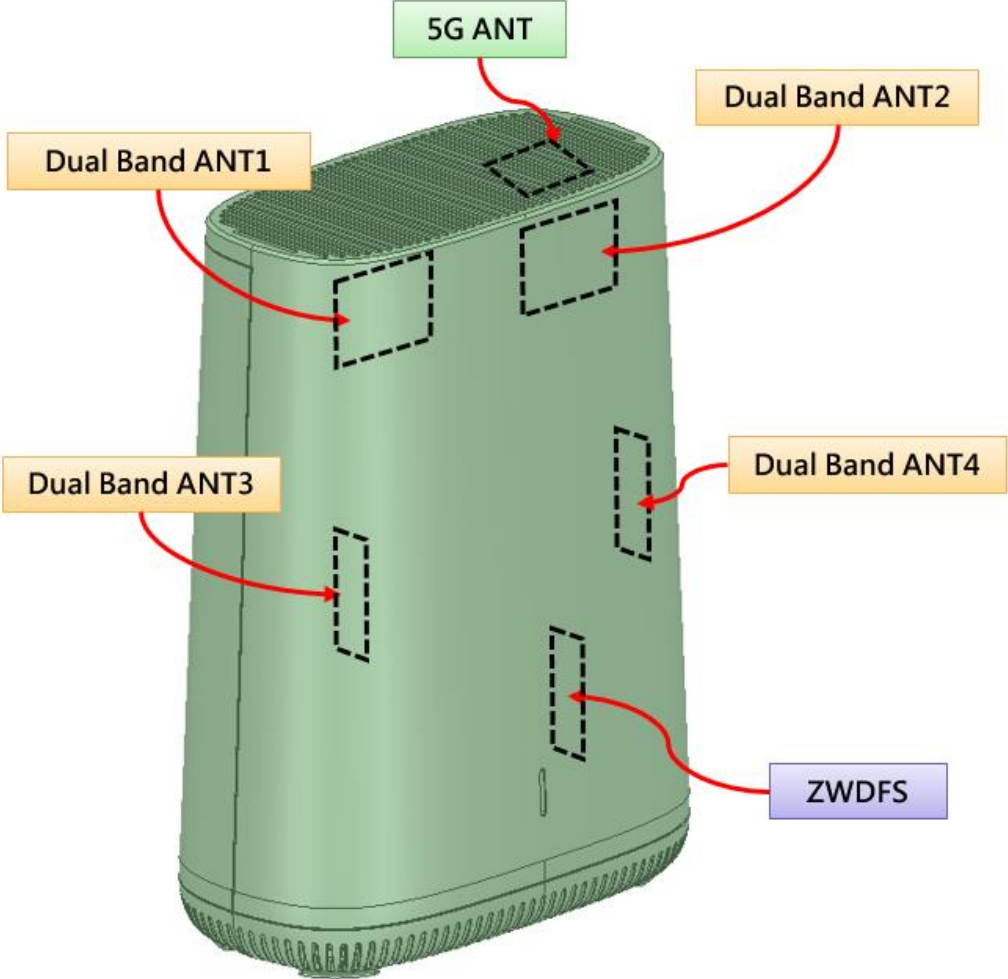
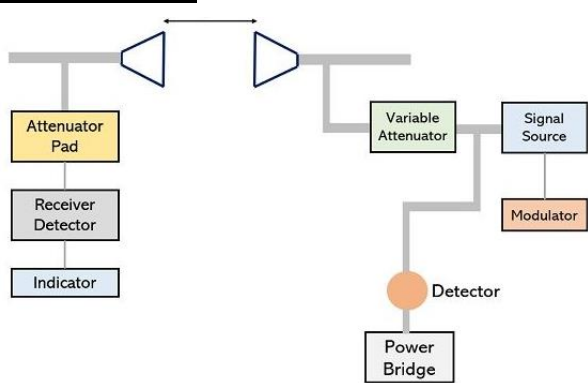
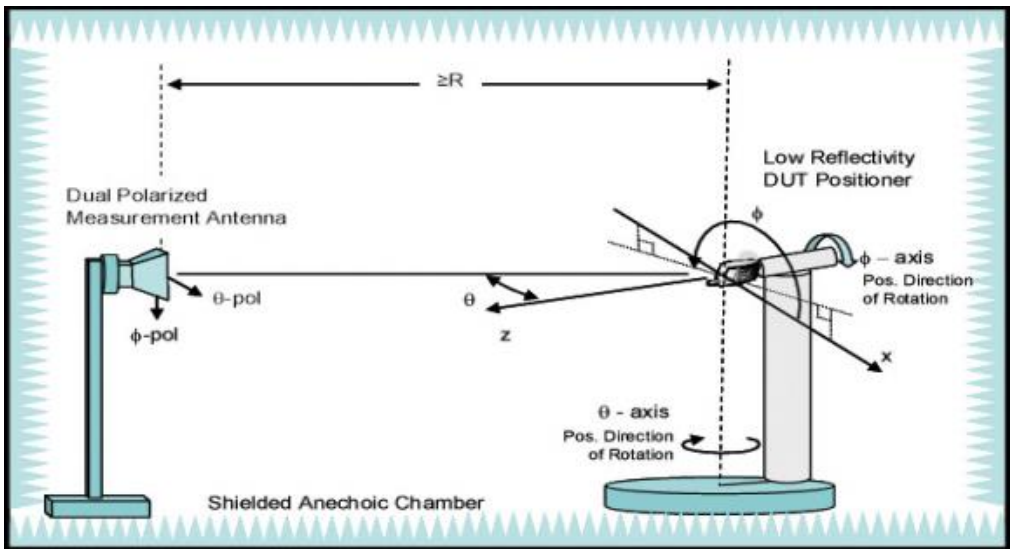


Antenna Test Report

Antenna System Description					
Brand name	Gemtek				
Model name	WRTM-406BE				
Manufacturer	Gemtek Technology Co., Ltd. No. 15-1 Zhonghua Road, Hsinchu Industrial Park, Hukou, Hsinchu, Taiwan, 30352.				
Geometric placement					
	Ant NO	Tx-Rx	Type	connector	Support Band
	Dual Band ANT1	2.4G/5G Tx-Rx	PIFA	UFL	2.4GHz/5GHz
	Dual Band ANT2		PIFA	UFL	2.4GHz/5GHz
	Dual Band ANT3		PIFA	UFL	2.4GHz/5GHz
	Dual Band ANT4		PIFA	UFL	2.4GHz/5GHz
	5G ANT	5G Tx-Rx	PIFA	UFL	5GHz
	ZWDFS	5G Rx	PIFA	UFL	5GHz Rx only
Generate multiple beams	No supports				

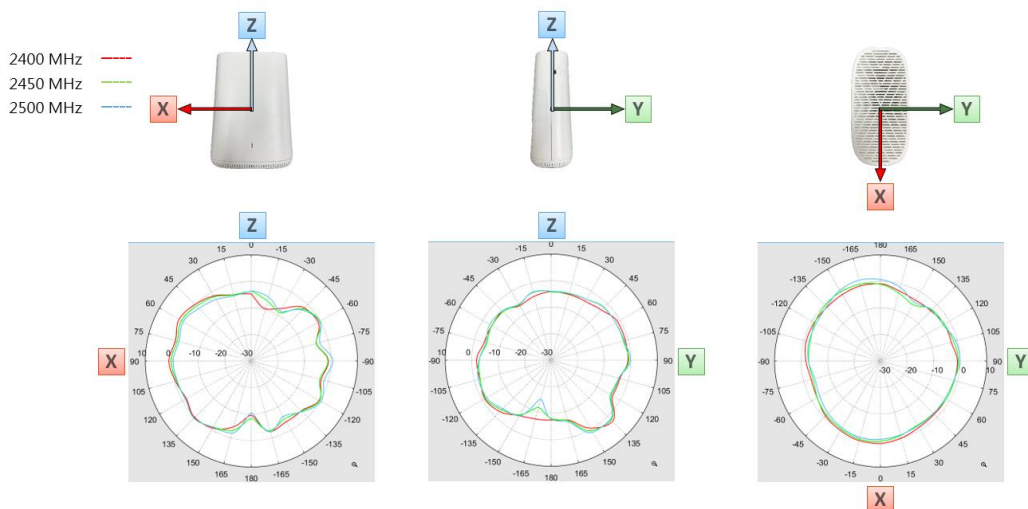
Measurement Quantity	
Operation bands of EUT Wi-Fi 2.4GHz : 2.412 / 2.4835 GHz Wi-Fi 5GHz : UNII-1 / 2A / 2C / 3	
Measurement Method	
	Absolute gain  Suppose the two antennas (transmitting and receiving) are separated at a distance r. Here, P_t and P_r represent the transmitted and received power respectively. While A_{et} and A_{er} are the effective apertures of transmitting and receiving antennas. As the two antennas are identical. Therefore, $A_{et} = A_{er} = \frac{G_0 \lambda^2}{4\pi}$ By Friis's transmission equation, $\frac{P_r}{P_t} = \left(\frac{A_{et} A_{er}}{\lambda^2 r^2} \right) = \left(\frac{G_0 \lambda^2}{4\pi} \right) \left(\frac{G_0 \lambda^2}{4\pi} \right) \frac{1}{\lambda^2 r^2}$ $\frac{P_r}{P_t} = \left(\frac{G_0 \lambda}{4\pi r} \right)^2$ $\sqrt{\frac{P_r}{P_t}} = \frac{G_0 \lambda}{4\pi r}$ Thus, $G_0 = \frac{4\pi r}{\lambda} \sqrt{\frac{P_r}{P_t}}$ While if we consider the effect of direct and indirect rays in case of ground reflection $G_0 = \frac{4\pi r}{\lambda F} \sqrt{\frac{P_r}{P_t}}$ then, : F is the propagation constant due to interference. <i>Gain = $\frac{\text{Maximum amount of power received from subject antenna}}{\text{Maximum amount of power received from reference antenna}}$</i> Hence, $G = \frac{P_1}{P_2}$

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Measurement Environment																			
Chamber type	Operation Band: 700 MHz ~ 18 GHz Chamber Size: 7m(L) * 3.5m(W) * 3.5m(H)																		
	  R&S ZNB 8																		
Antenna type	Types of measurement antennas (Frequency Range)																		
Test Equipment	<table><tr><th>Instrument</th><th>Brand</th><th>Model No.</th></tr><tr><td>VNA</td><td>ROHDE & SCHWARZ</td><td>ZNB8</td></tr><tr><td>Test Software</td><td>Atenlab</td><td>Maxwell 3.8.2</td></tr><tr><td>Switch</td><td>Atenlab</td><td>4SW_P_2019</td></tr><tr><td>Turntable</td><td>Atenlab</td><td>Aten Dual Axis</td></tr><tr><td>Horn Antenna</td><td>ETS-Lindgren</td><td>3164-10</td></tr></table>	Instrument	Brand	Model No.	VNA	ROHDE & SCHWARZ	ZNB8	Test Software	Atenlab	Maxwell 3.8.2	Switch	Atenlab	4SW_P_2019	Turntable	Atenlab	Aten Dual Axis	Horn Antenna	ETS-Lindgren	3164-10
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Horn Antenna	ETS-Lindgren	3164-10																	
Coordinate difinition																			

Dual Band
ANT1 Gain
Total (dBi)
Pattern

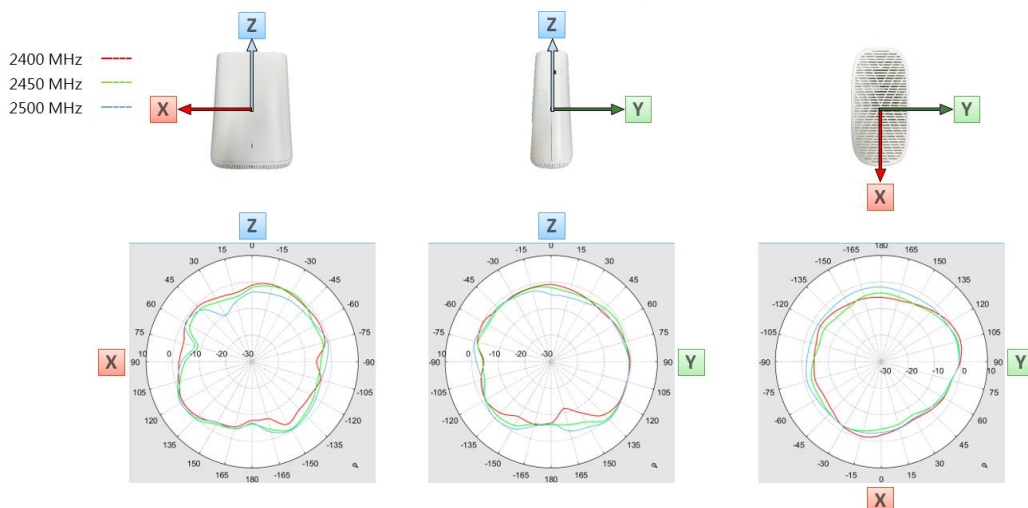
Dual Band ANT1 Gain Total (dBi) Pattern @2.4GHz



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Dual Band
ANT2 Gain
Total (dBi)
Pattern

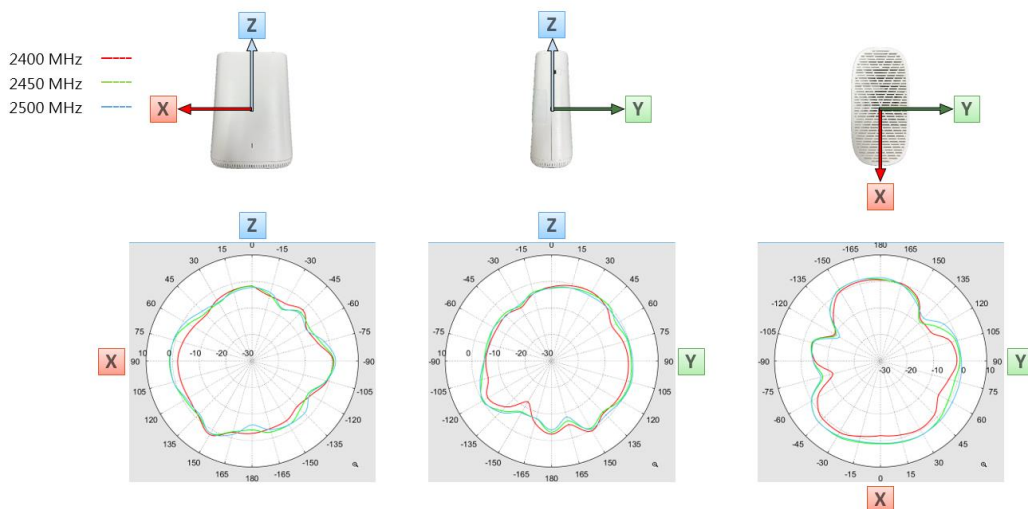
Dual Band ANT2 Gain Total (dBi) Pattern @2.4GHz



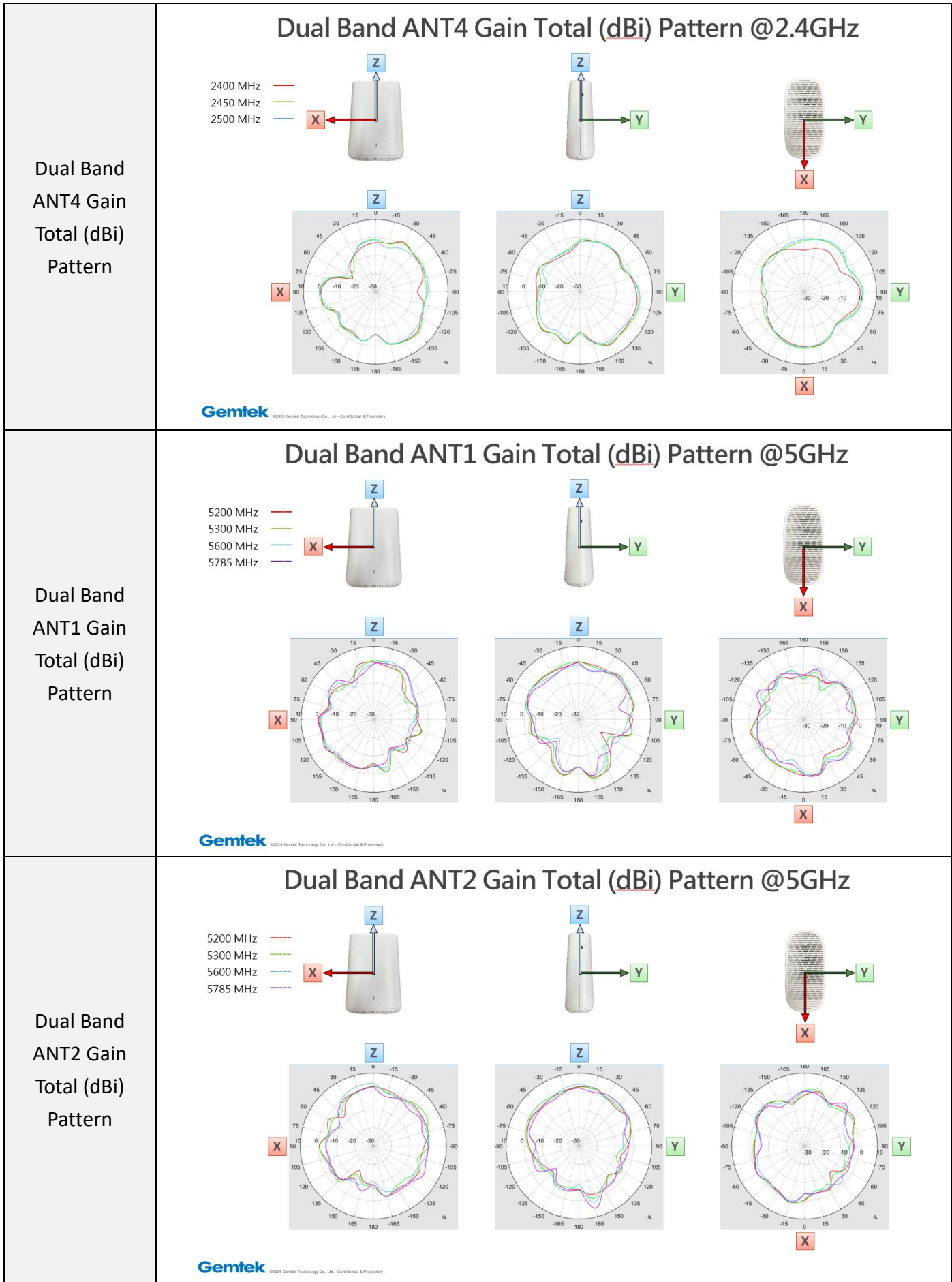
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Dual Band
ANT3 Gain
Total (dBi)
Pattern

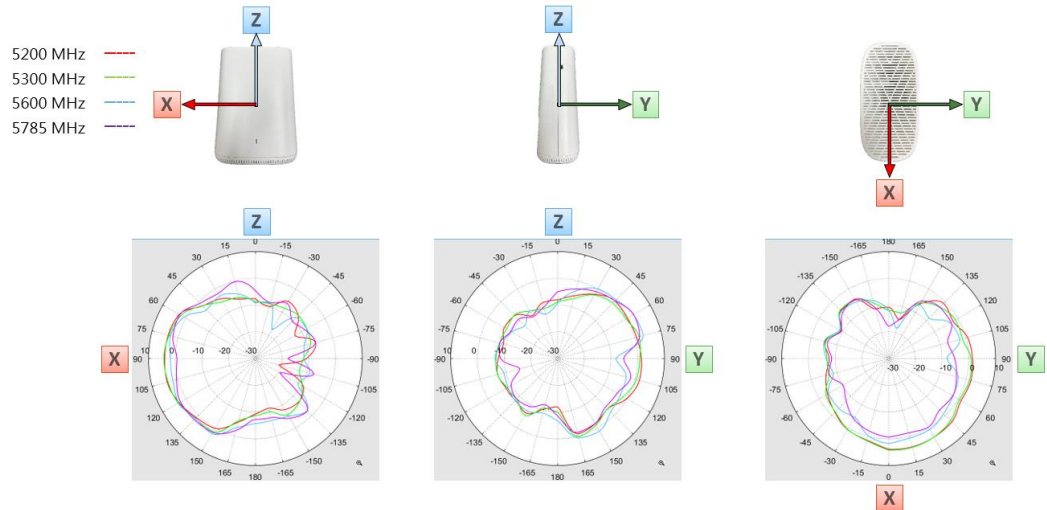
Dual Band ANT3 Gain Total (dBi) Pattern @2.4GHz



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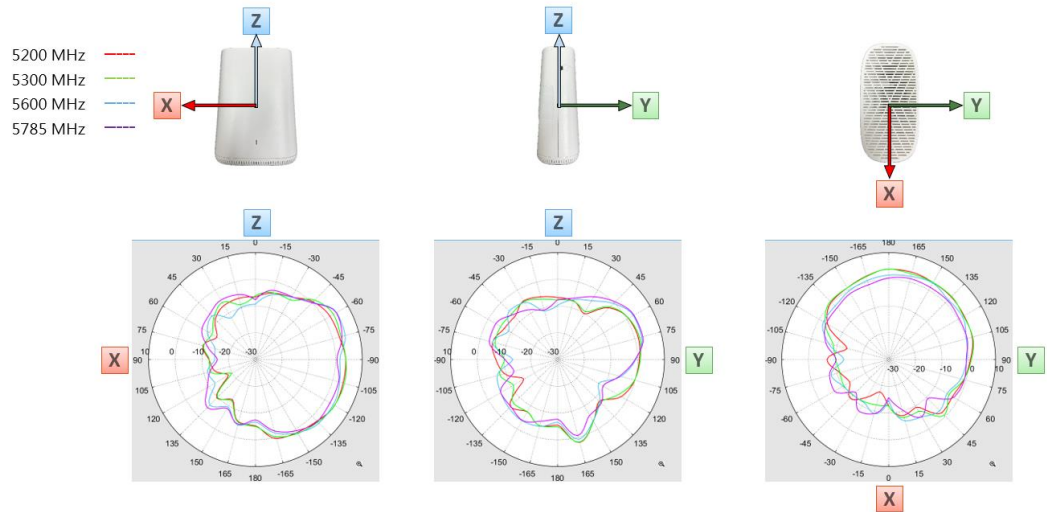


Dual Band ANT3 Gain Total (dBi) Pattern @5GHz



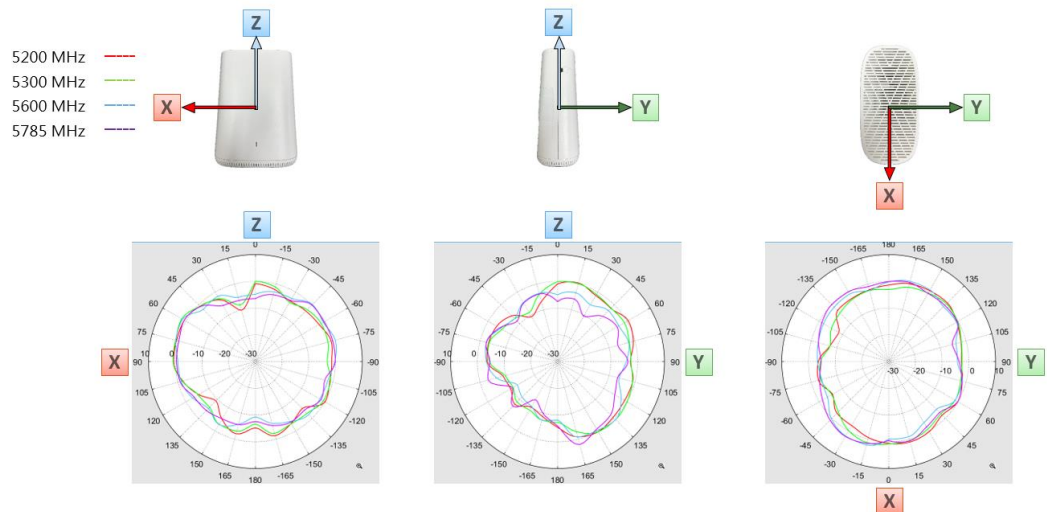
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Dual Band ANT4 Gain Total (dBi) Pattern @5GHz

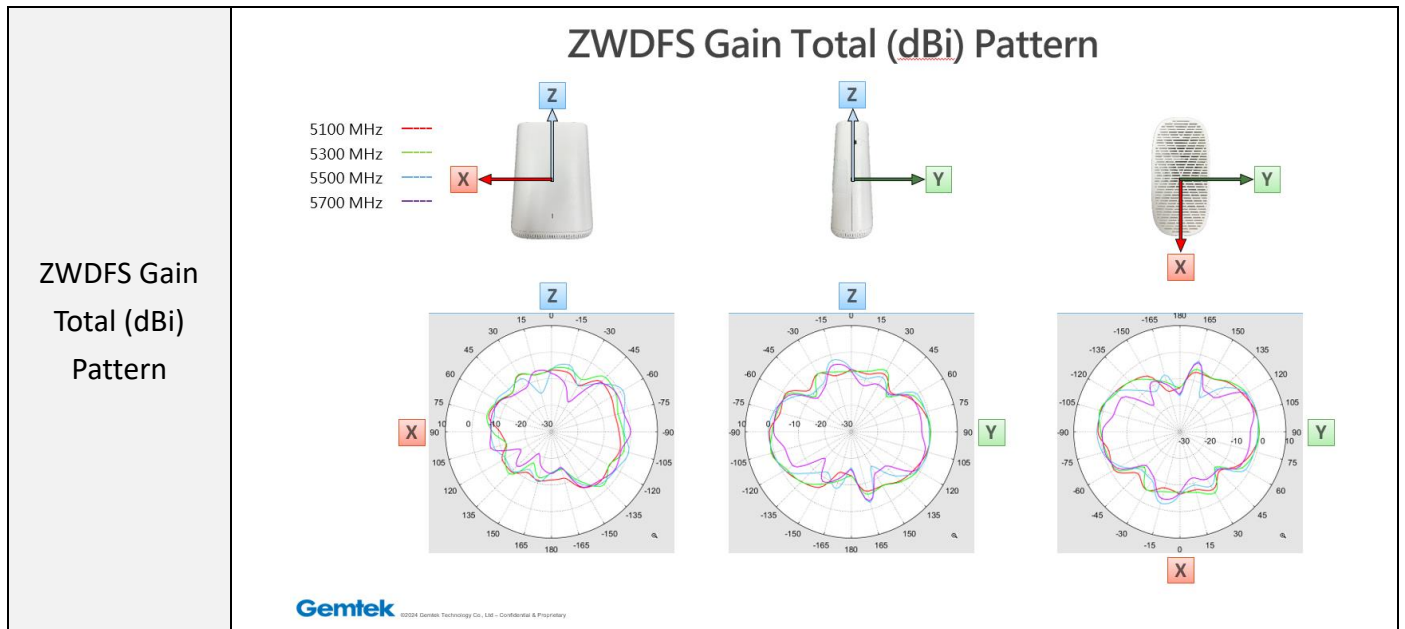


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5G ANT Gain Total (dBi) Pattern



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ZWDFS Antenna Efficiency & Peak Gain

WIFI A Band Antenna Efficiency (%)

Frequency (GHz)	5.1	5.3	5.5	5.7
ZWDFS	66.2	68.8	67.5	67.2

WIFI A Band Antenna Peak Gain (dB)

Frequency (GHz)	5.1	5.3	5.5	5.7
ZWDFS	2.3	2.7	3.2	3.6

Peak Gain @2.4G/5G

Frequency (GHz)	2.45	5.2	5.3	5.6	5.785
Dual Band ANT1.Max Gain(dBi)	1.85	3.94	4.93	3.09	3.3
Dual Band ANT2.Max Gain(dBi)	1.19	2.74	3.01	4.23	5.28
Dual Band ANT3.Max Gain(dBi)	2.57	4.3	4.27	5.02	5.49
Dual Band ANT4.Max Gain(dBi)	2.72	3.13	3.95	4.91	3.95
5G ANT.Max Gain(dBi)	N/A	1.71	1.39	3.0	3.06
Dual Band ANT1 Polarization/Θ(°)/Φ(°)	phi/135/225	phi/165/75	phi/165/75	phi/165/75	phi/165/75
Dual Band ANT2 Polarization/Θ(°)/Φ(°)	phi/135/345	phi/30/90	theta/0/0	phi/15/285	phi/165/90
Dual Band ANT3 Polarization/Θ(°)/Φ(°)	phi/30/300	theta/60/45	theta/60/45	theta/60/60	theta/60/45
Dual Band ANT4 Polarization/Θ(°)/Φ(°)	theta/135/150	phi/120/180	theta/60/135	theta/75/105	theta/60/135
5G ANT Polarization/Θ(°)/Φ(°)	N/A	phi/60/105	phi/60/345	phi/75/330	phi/75/330
Max Gain (dBi)	2.72	4.3	4.93	5.02	5.49
DG [1SS] (dBi)	5.84	5.82	5.5	5.78	5.96
DG [2SS] (dBi)	2.84	4.3	4.93	5.02	5.49
DG [4SS] (dBi)	2.72	4.3	4.93	5.02	5.49

D.G @2.4G/5G

Frequency (GHz)	2.45	5.2	5.3	5.6	5.785
Dual Band ANT1 (dBi)	1.69	3.23	3.68	1.91	-12.8
Dual Band ANT2 (dBi)	-0.69	-4.48	-5.02	1.62	3.5
Dual Band ANT3 (dBi)	-3.76	-7.31	-8.8	-9.97	-6.72
Dual Band ANT4 (dBi)	1.08	-1.37	-1.24	-3.57	0.93
5G ANT (dBi)	N/A	0.31	-0.98	-0.74	1.15
DG [1SS] (dBi)	5.84	5.82	5.50	5.78	5.96
Polarization	theta	phi	phi	phi	phi
Theta	135	165	165	165	165
Phi	105	60	60	90	90
Frequency (GHz)	2.45	5.2	5.3	5.6	5.785
Dual Band ANT1 [10^(G/20)]	10^(1.69/20)	10^(3.23/20)	10^(3.68/20)	10^(1.91/20)	10^(-12.8/20)
Dual Band ANT2 [10^(G/20)]	10^(-0.69/20)	10^(-4.48/20)	10^(-5.02/20)	10^(1.62/20)	10^(3.5/20)
Dual Band ANT3 [10^(G/20)]	10^(-3.76/20)	10^(-7.31/20)	10^(-8.8/20)	10^(-9.97/20)	10^(-6.72/20)
Dual Band ANT4 [10^(G/20)]	10^(1.08/20)	10^(-1.37/20)	10^(-1.24/20)	10^(-3.57/20)	10^(0.93/20)
5G ANT [10^(G/20)]	N/O	10^(0.31/20)	10^(-0.98/20)	10^(-0.74/20)	10^(1.15/20)
Dual Band ANT1 [10^(G/20)] Value	1.21	1.45	1.53	1.25	0.23
Dual Band ANT2 [10^(G/20)] Value	0.92	0.6	0.56	1.21	1.50
Dual Band ANT3 [10^(G/20)] Value	0.65	0.43	0.36	0.32	0.46
Dual Band ANT4 [10^(G/20)] Value	1.13	0.85	0.89	0.66	1.11
5G ANT [10^(G/20)] Value	N/O	1.04	0.89	0.92	1.14
Sum All Antenna [Amax]	3.91	4.37	4.21	4.35	4.44
DG [10*log(Amax^2/Nant)]	5.84	5.82	5.50	5.78	5.96