



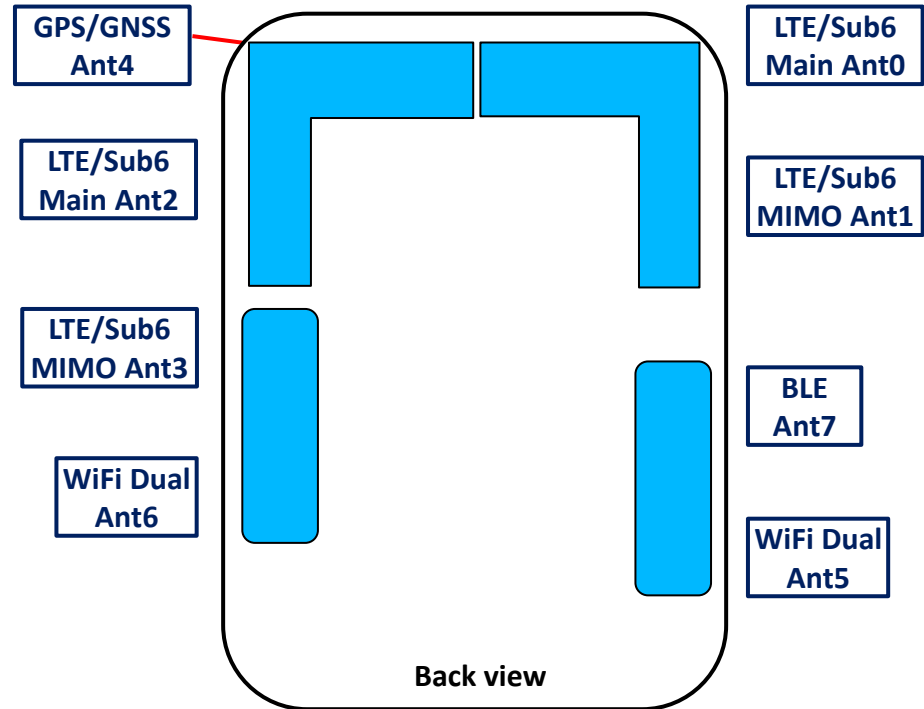
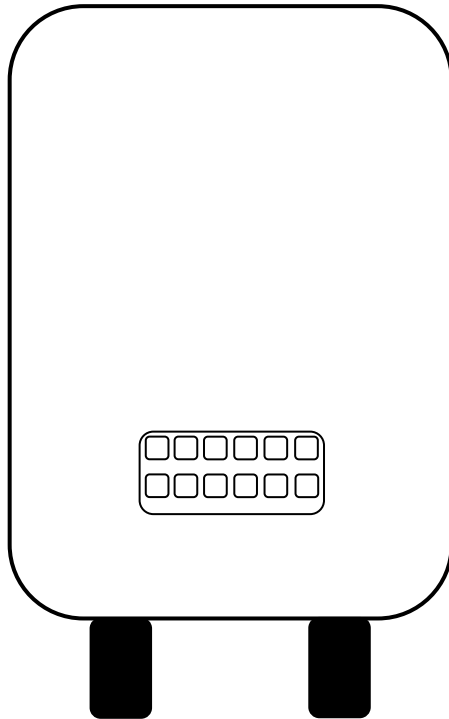
FER-511G

Antenna Test Report

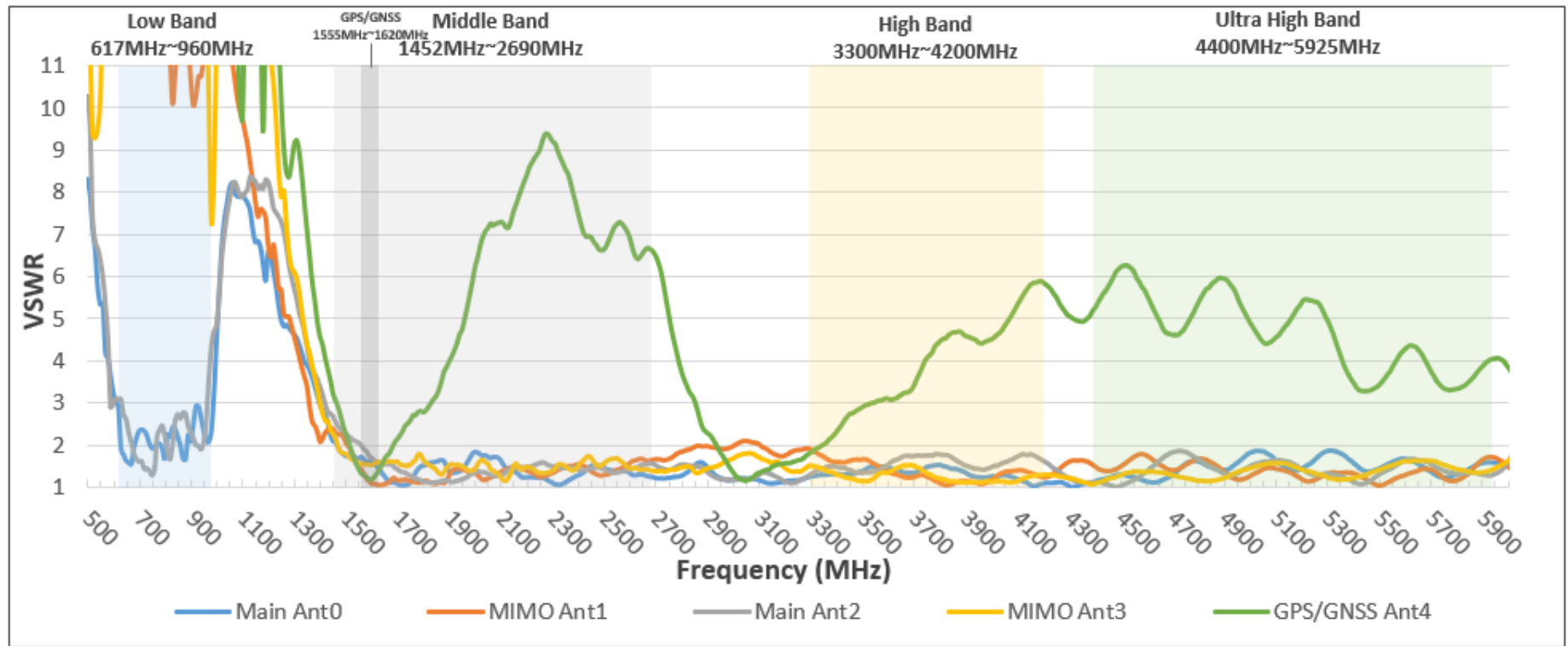
Senao Networks, Inc.

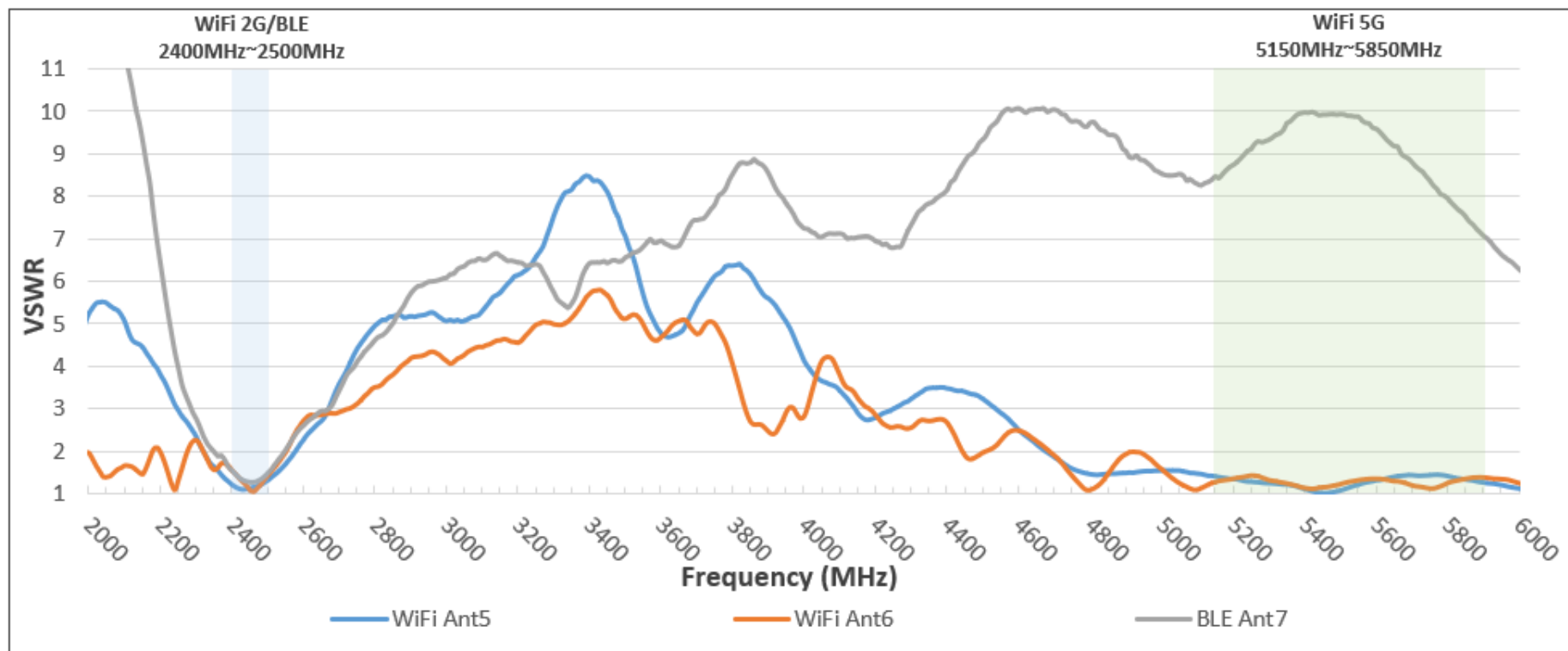
Customer	Fortinet
Project	FER-511G
Project Description	Sub-6 antenna*4 GPS antenna*1 WiFi Dual antenna*2 BLE antenna*1
Date	2024/06/20
Prepared by	Tony/Kenny
Report Version	A05

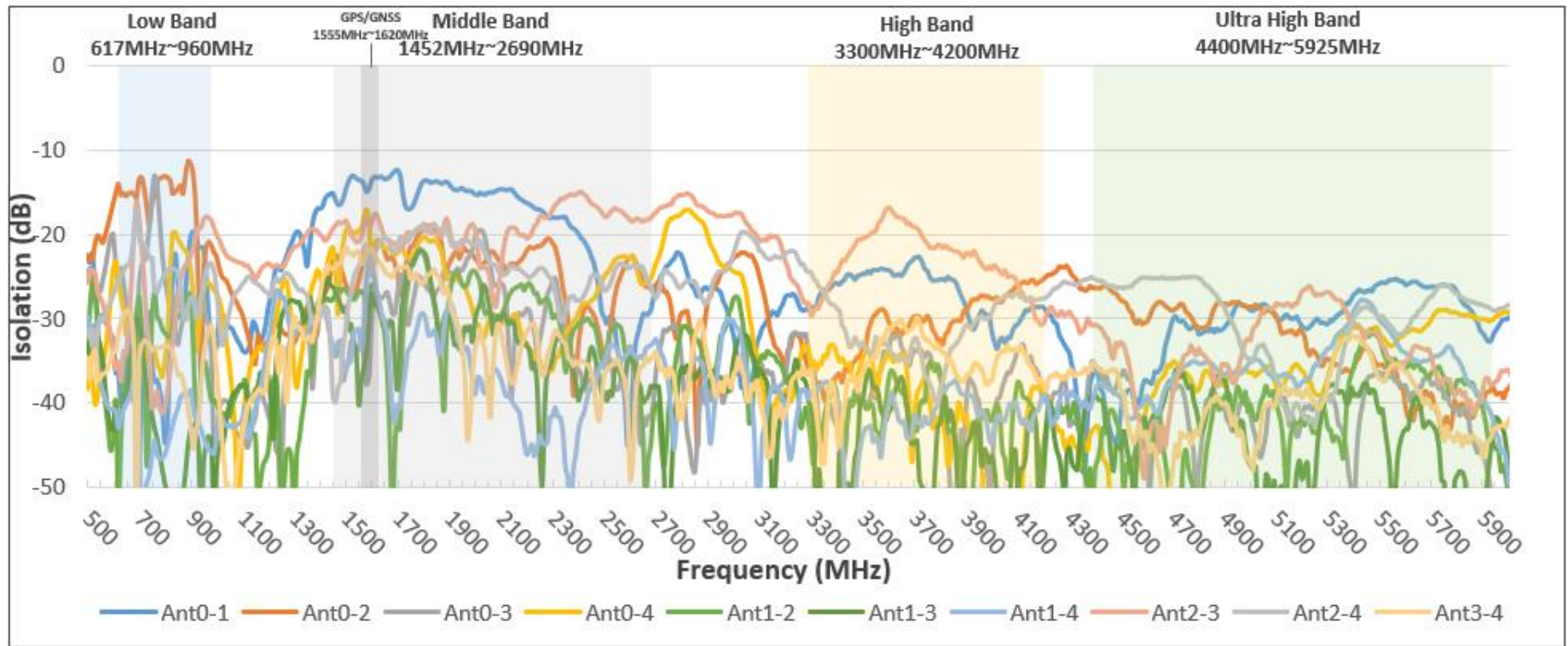
- **Agenda**
 - Placement and Specification
 - VSWR & Isolation
 - Radiation Pattern
 - Combine Pattern - WiFi
 - Efficiency and Gain

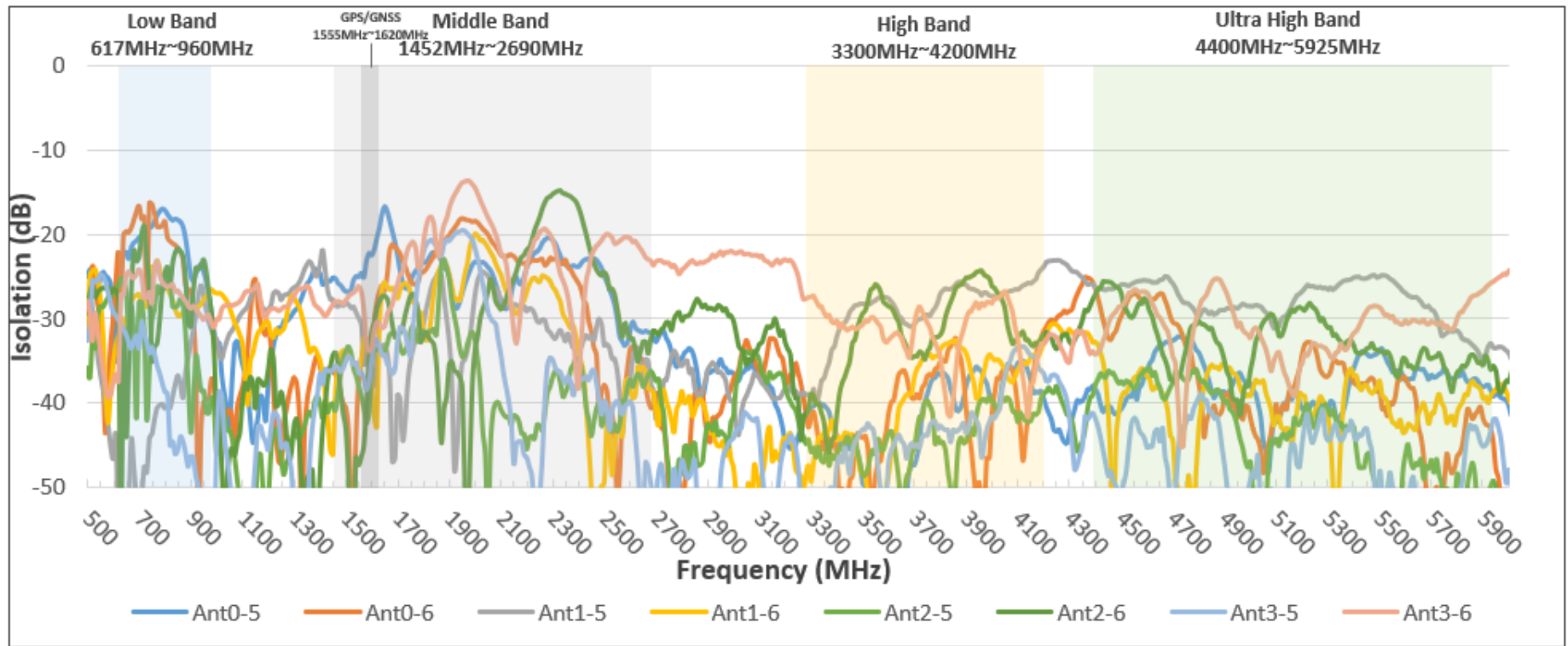


Ant No.	Brand	Antenna P/N	Operating Band	Ant Type	Material	Feeding	Dimension
Main Ant0	AWAN	A8L8Y-200001	617~960, 1450~2690, 3300~5925 MHz	Monopole	LDS	Cable	84*84*27.8 mm ³
MIMO Ant1	AWAN	A8L8Y-200001	1450~2690, 3300~5925 MHz	Monopole	LDS	Cable	84*84*27.8 mm ³
Main Ant2	AWAN	A8L8Y-200000	617~960, 1450~2690, 3300~5925 MHz	Monopole	LDS	Cable	84*84*27.8 mm ³
MIMO Ant3	AWAN	A8L8M-200000	1450~2690, 3300~5925 MHz	Monopole	LDS	Cable	90*20*27.8 mm ³
GPS/GNSS Ant4	AWAN	A8L8Y-200000	1555~1610 MHz	PIFA	LDS	Cable	84*84*27.8 mm ³
WiFi Dual Ant5	AWAN	A8L8P-200000	2400~2500, 5150~5850 MHz	Dipole	LDS	Cable	90*20*27.8 mm ³
WiFi Dual Ant6	AWAN	A8L8M-200000	2400~2500, 5150~5850 MHz	Dipole	LDS	Cable	90*20*27.8 mm ³
BLE Ant7	AWAN	A8L8P-200000	2400~2500 MHz	Dipole	LDS	Cable	90*20*27.8 mm ³

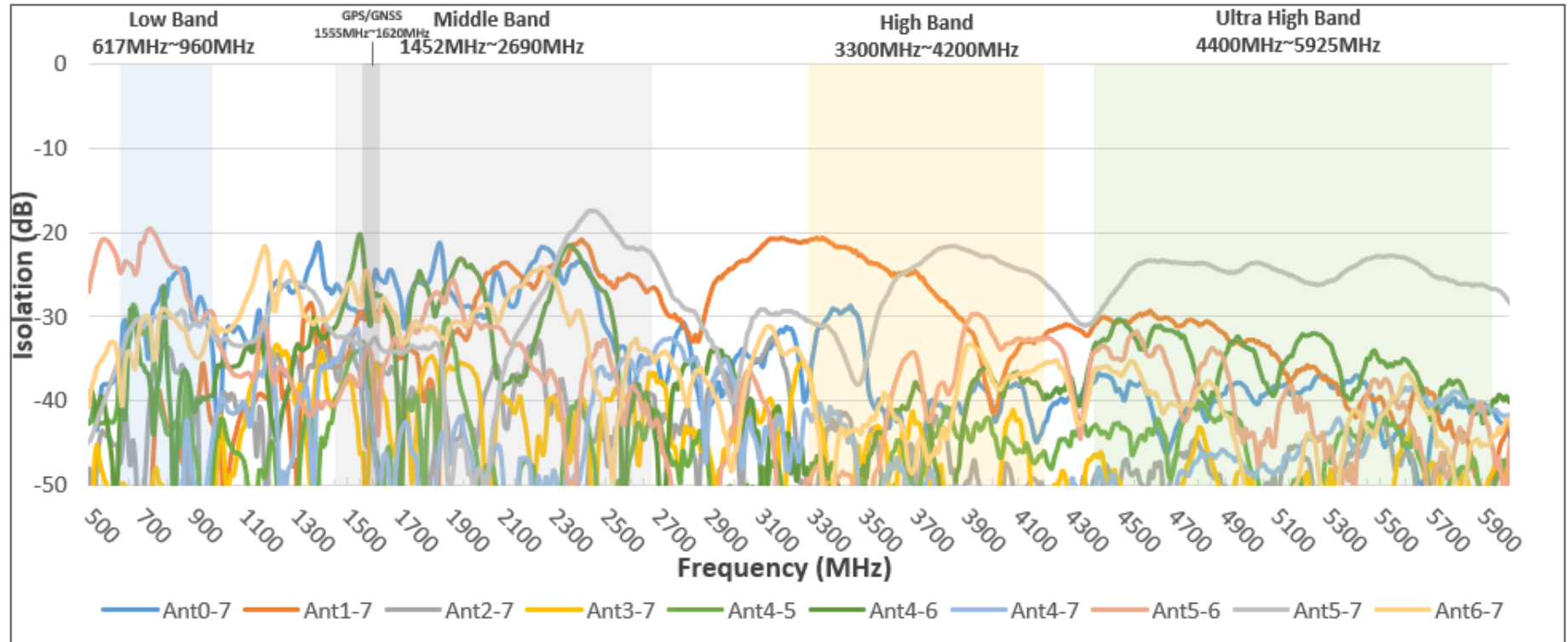


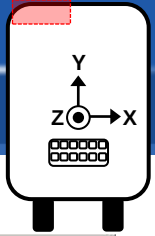




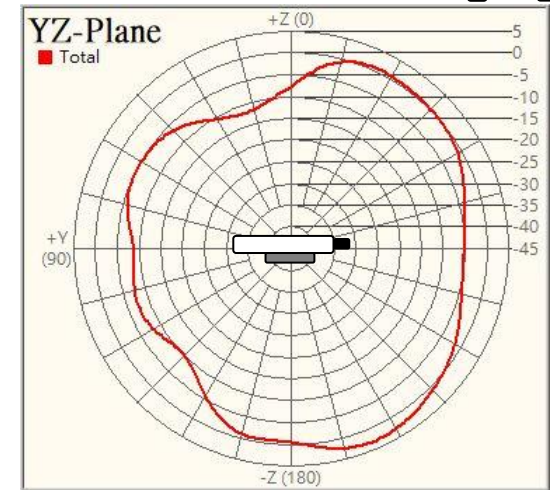
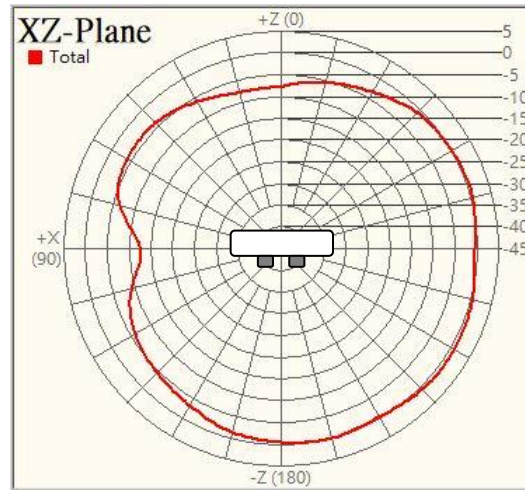
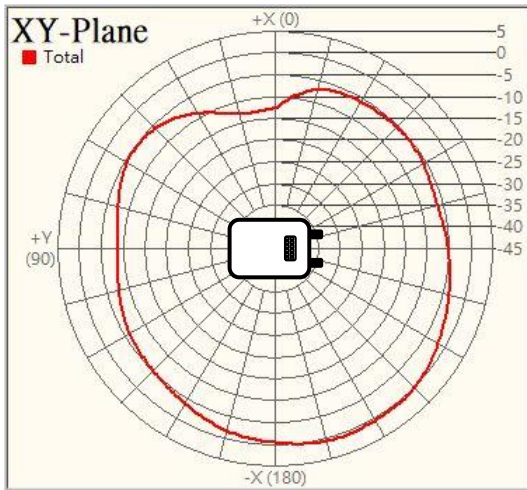


Isolation LTE Sub-6/GPS/WiFi/BLE

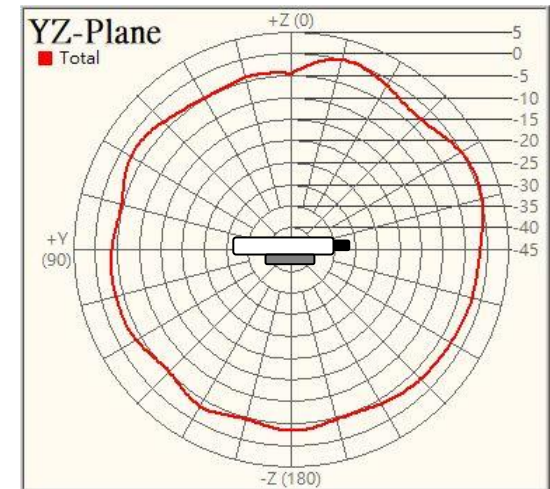
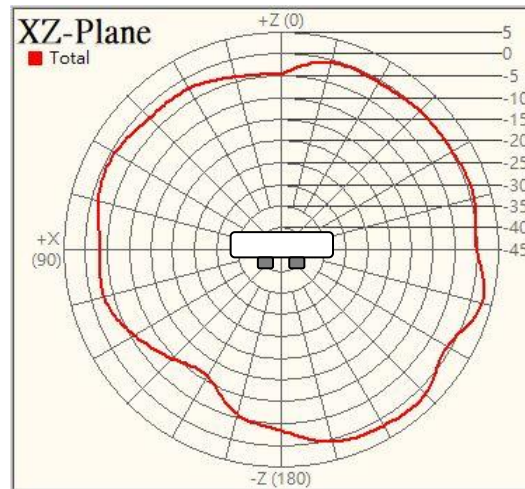
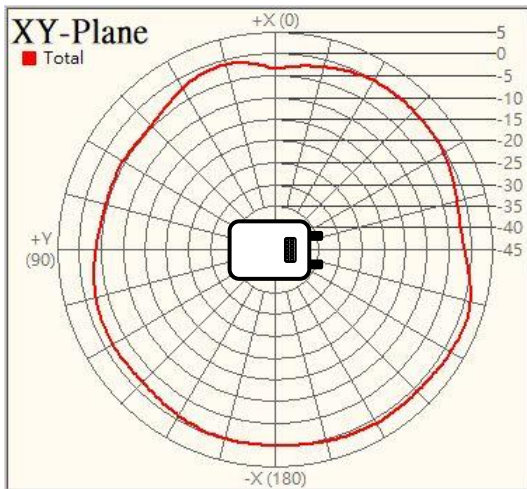


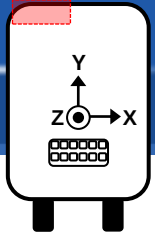


Low Band

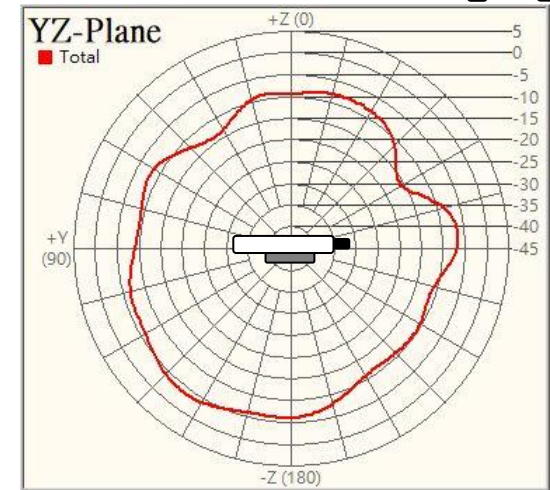
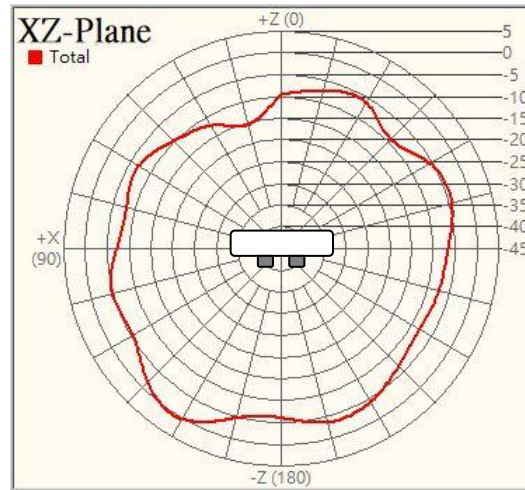
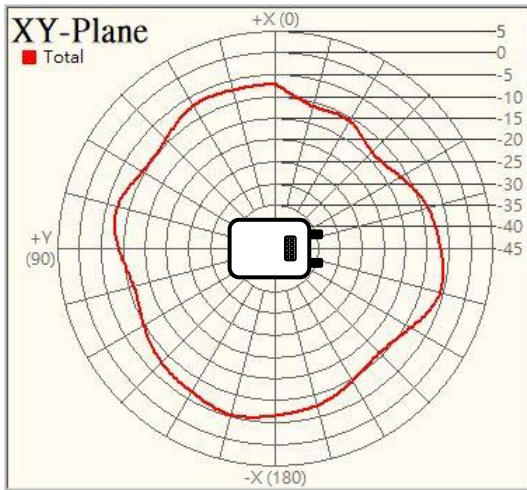


Middle Band

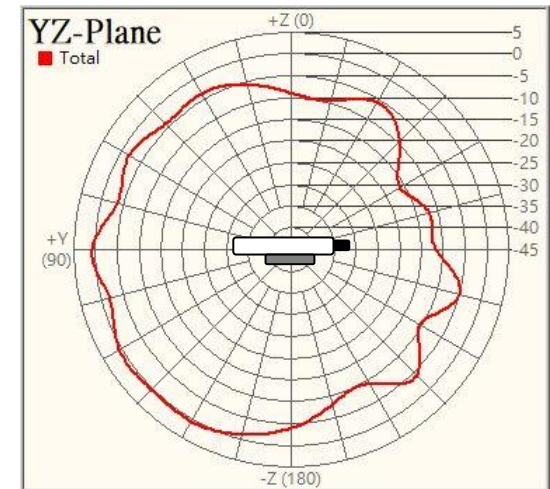
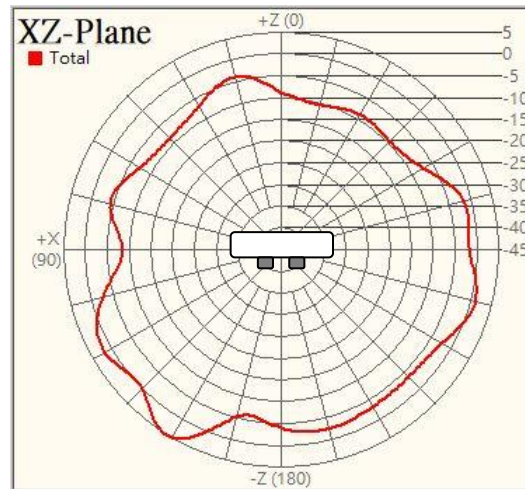
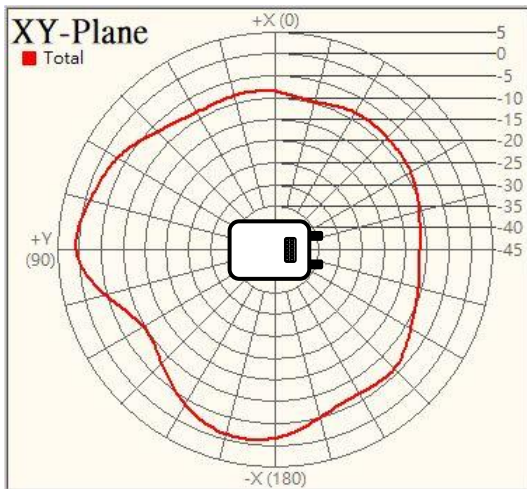


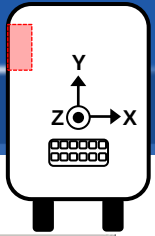


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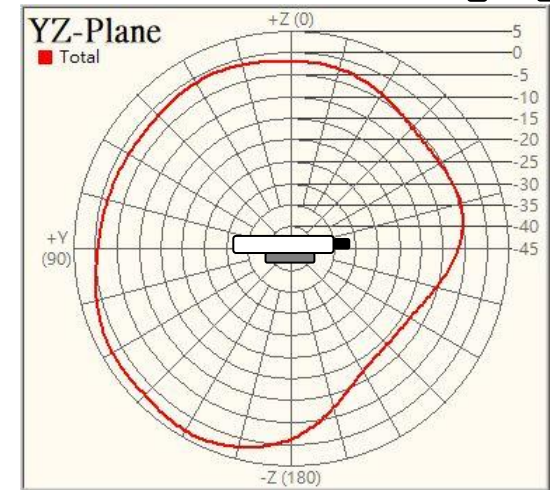
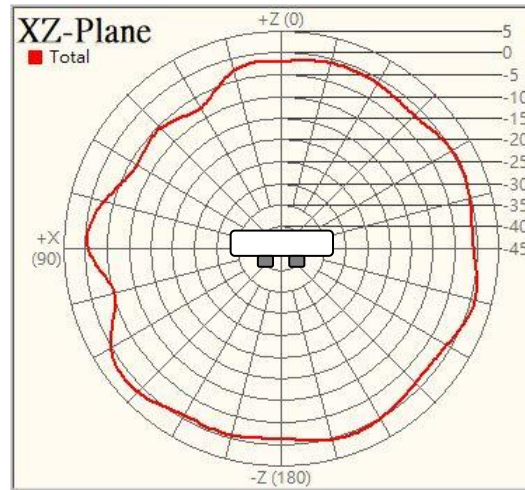
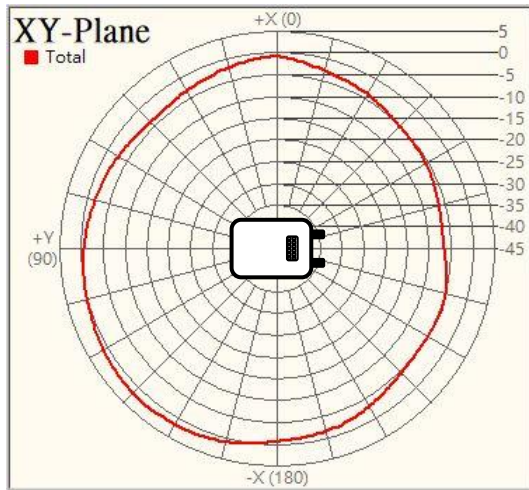


Ultra High Band

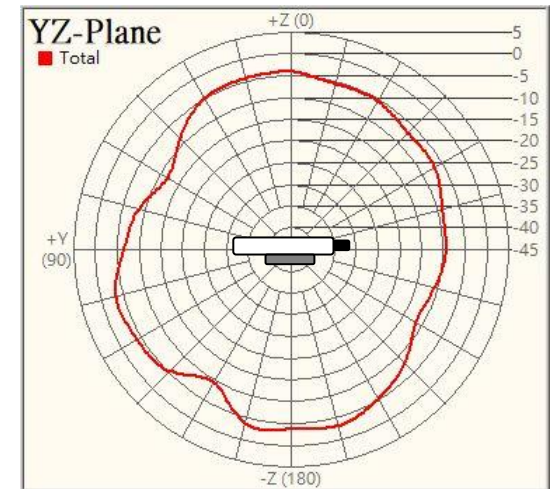
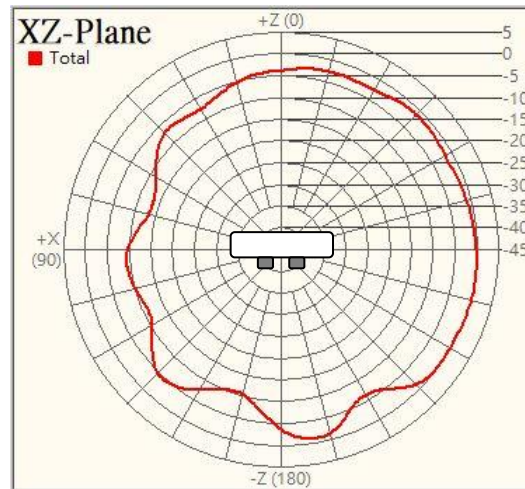
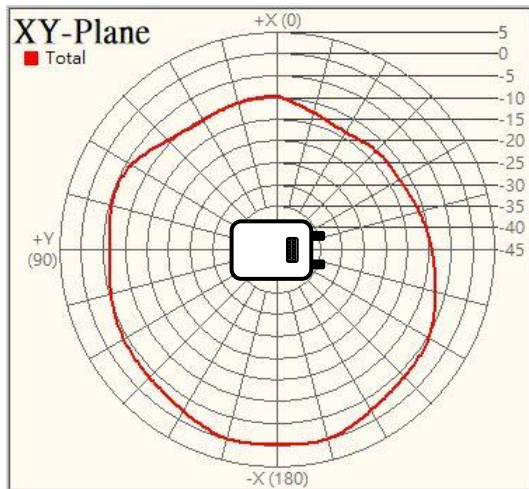


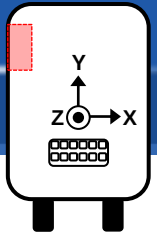


Middle Band

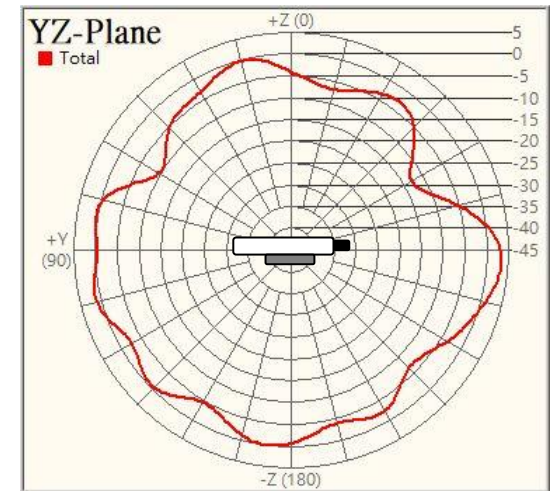
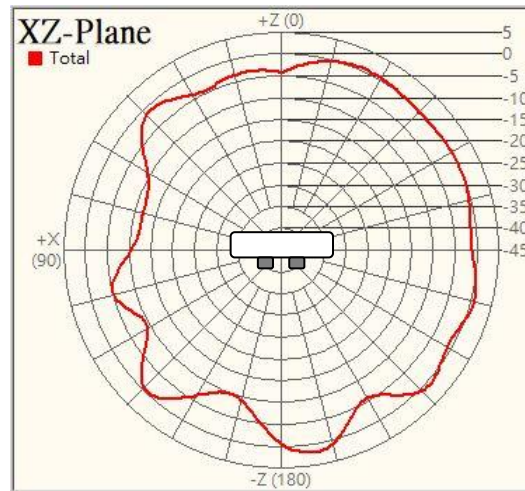
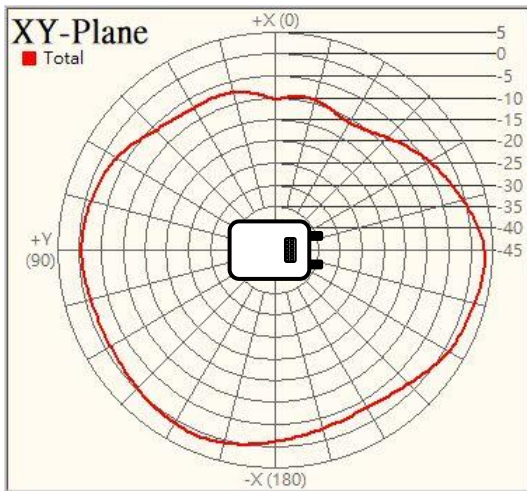


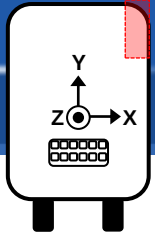
High Band



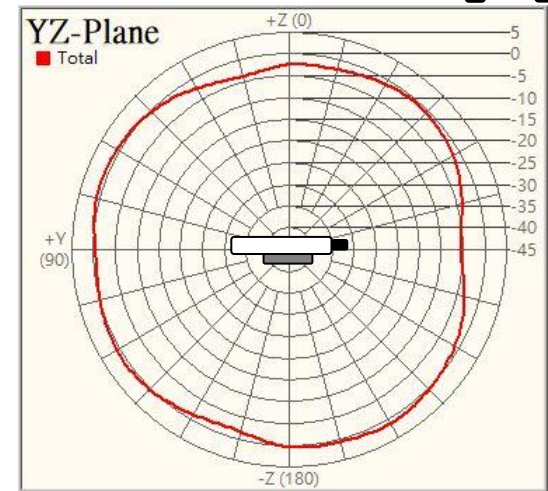
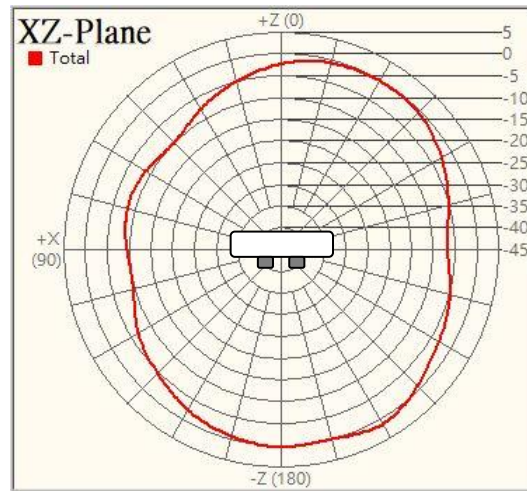
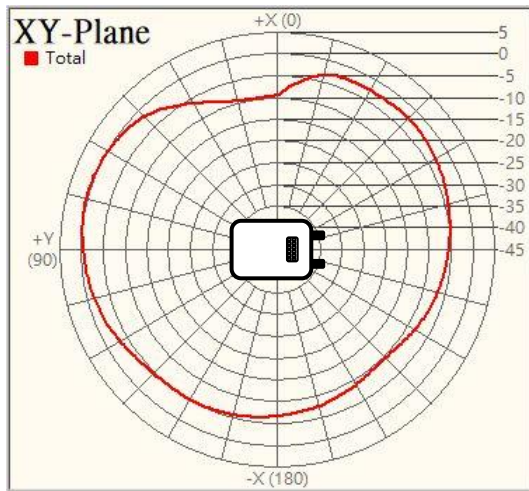


Ultra High Band

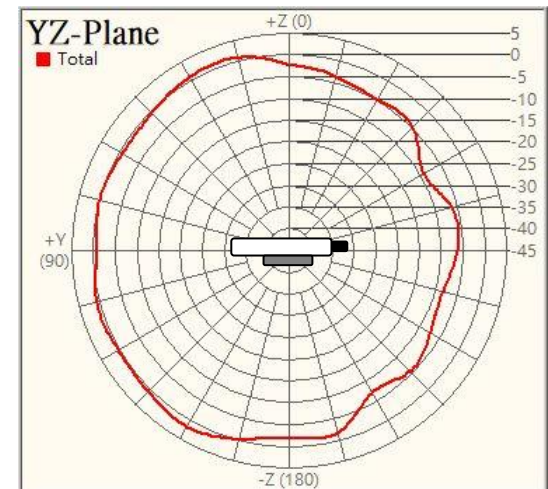
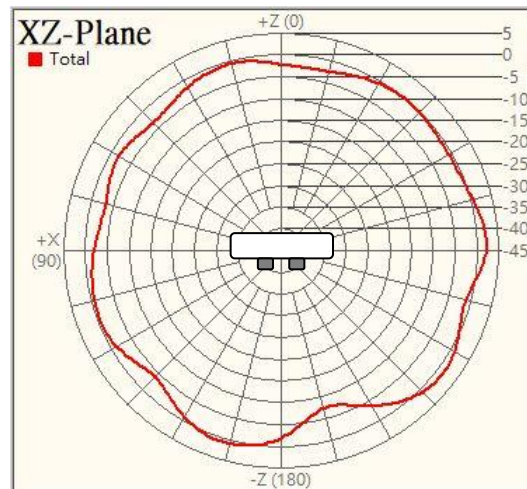
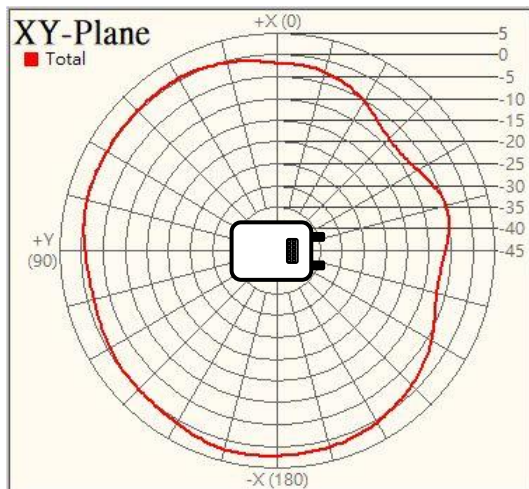


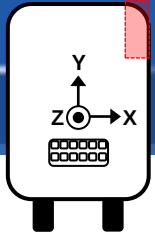


Low Band

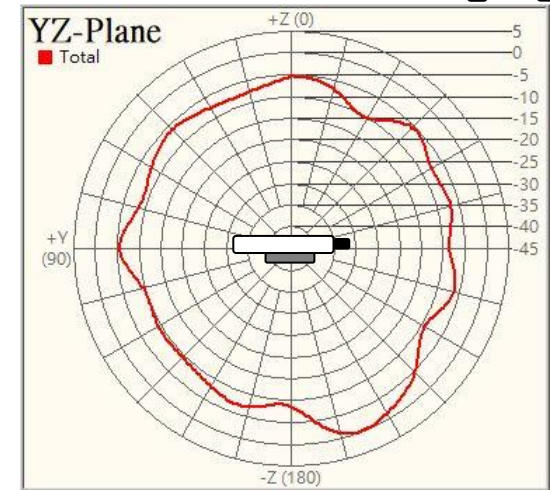
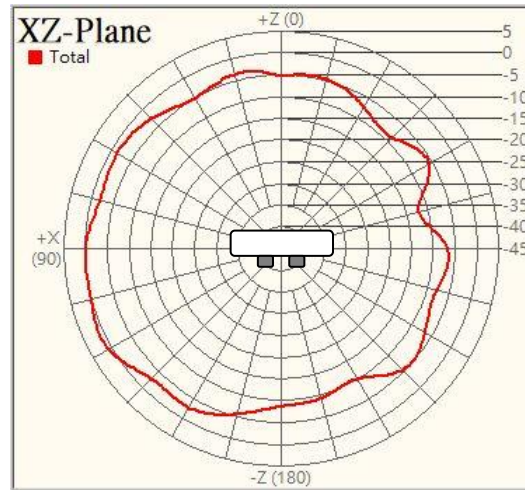
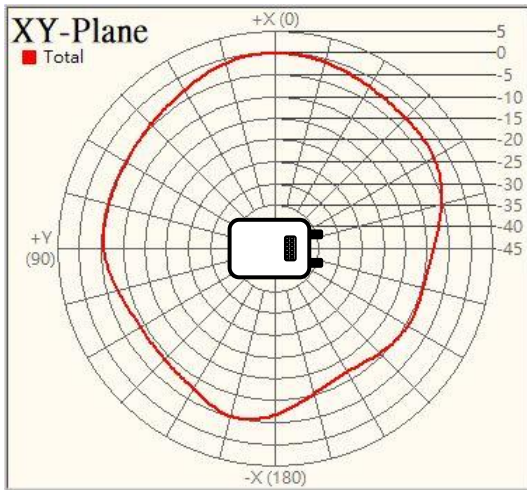


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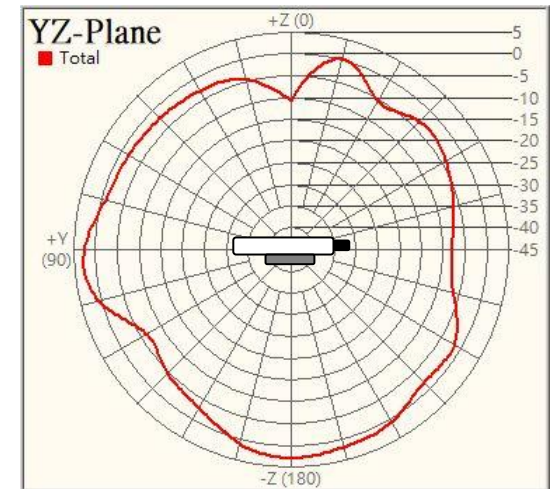
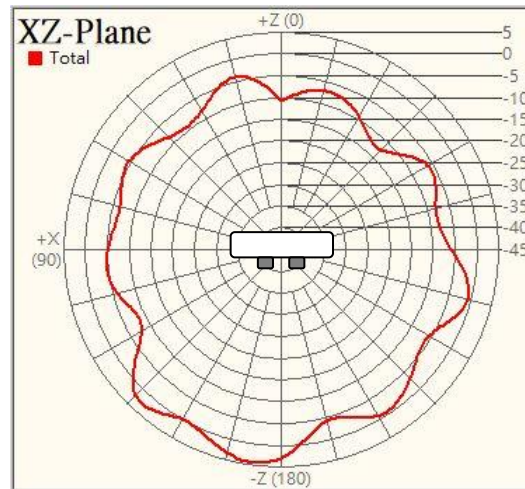
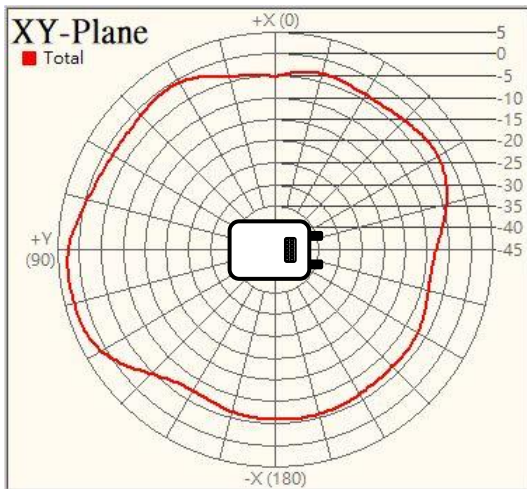


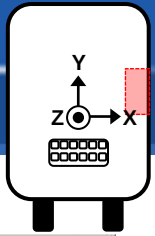


High Band

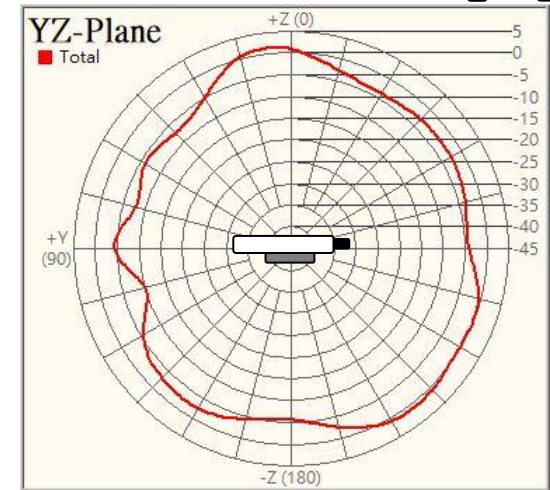
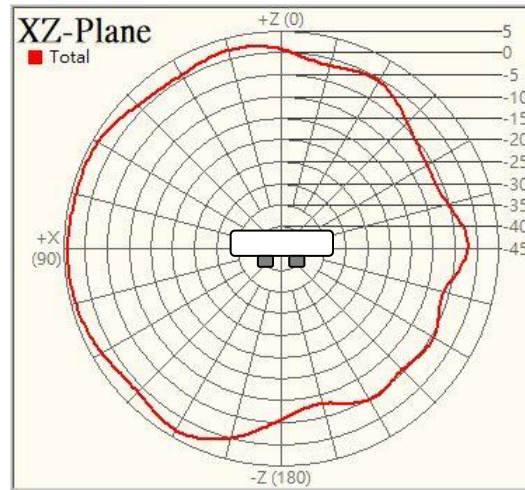
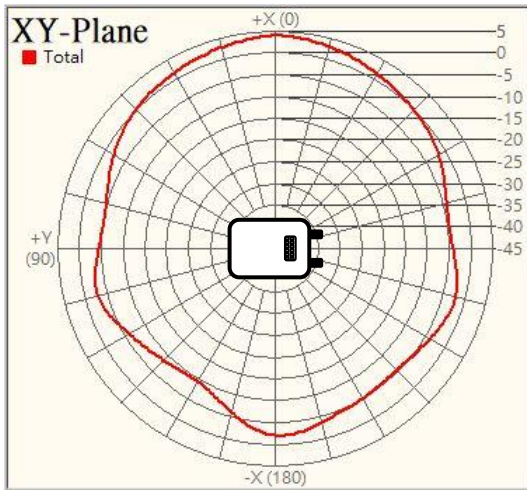


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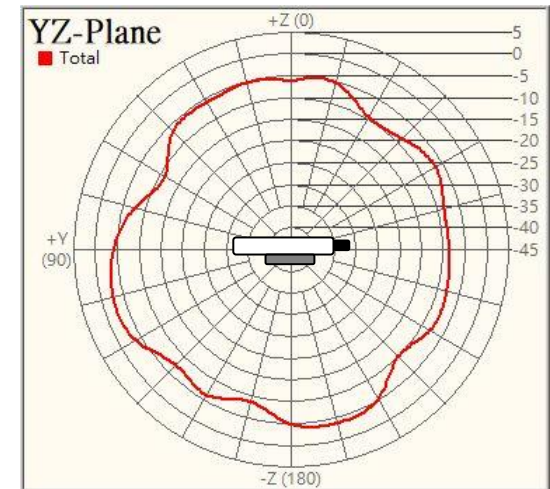
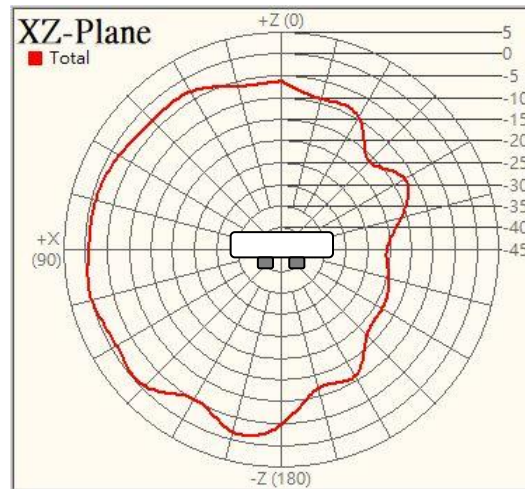
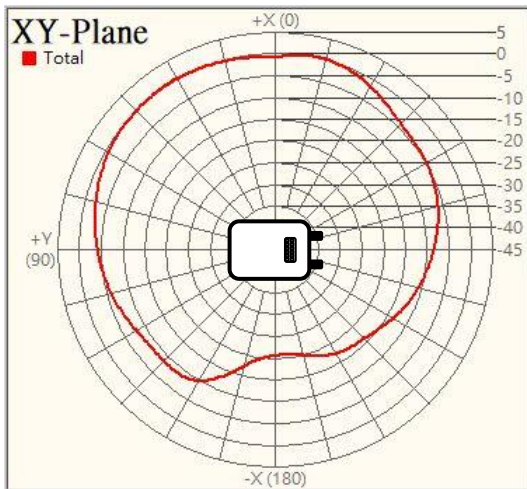


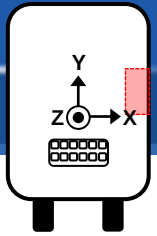


Middle Band

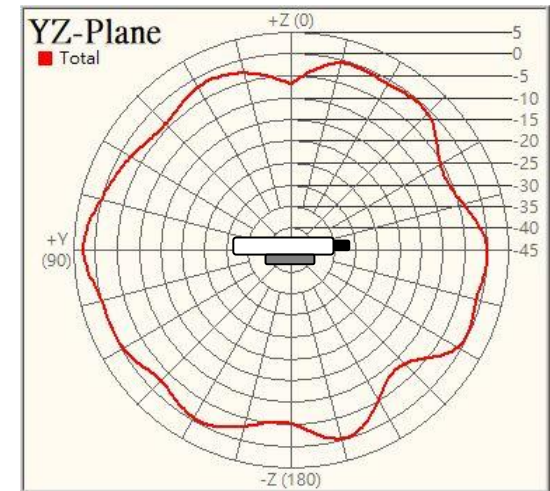
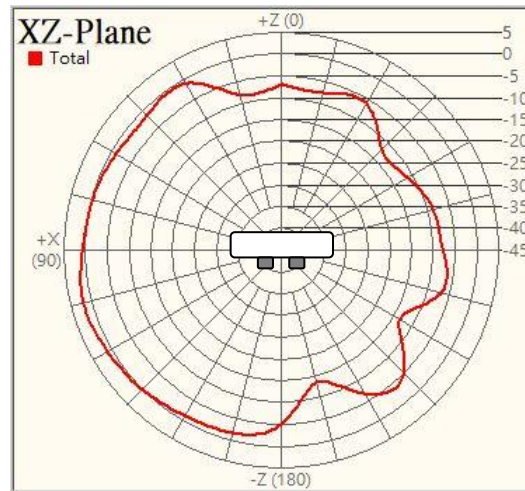
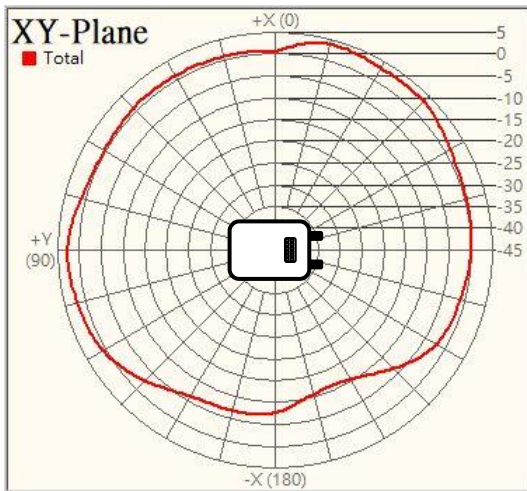


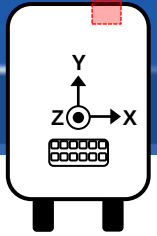
High Band



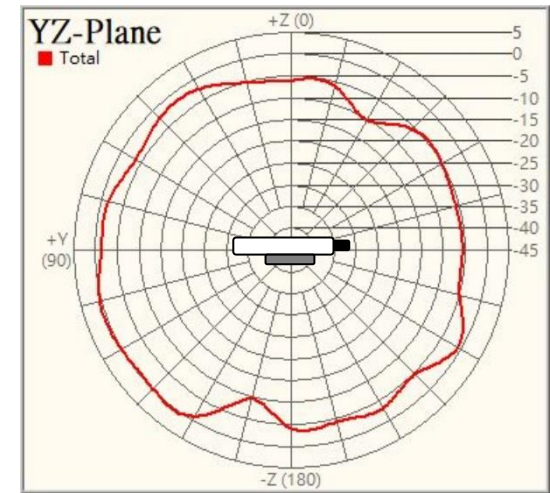
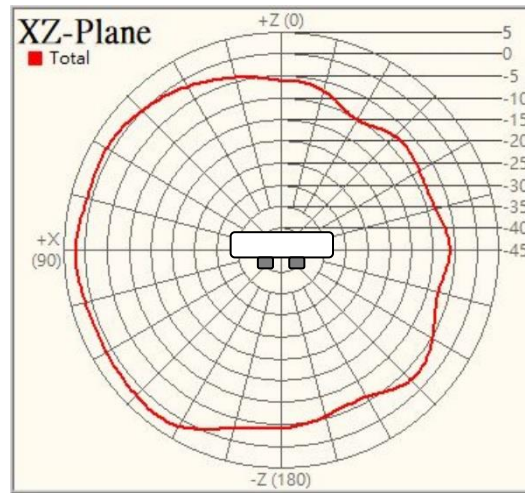
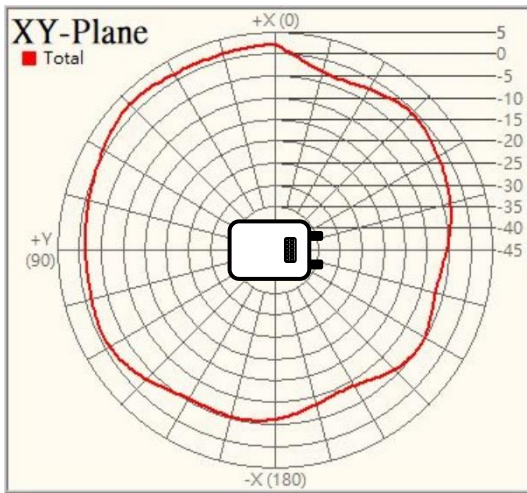


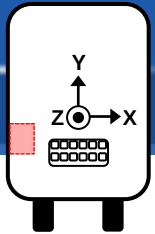
Ultra High Band



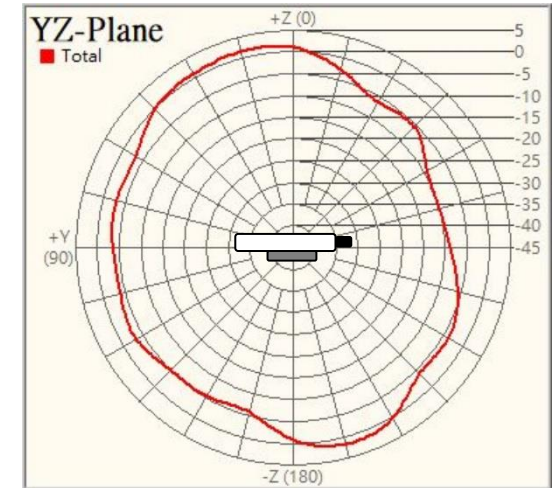
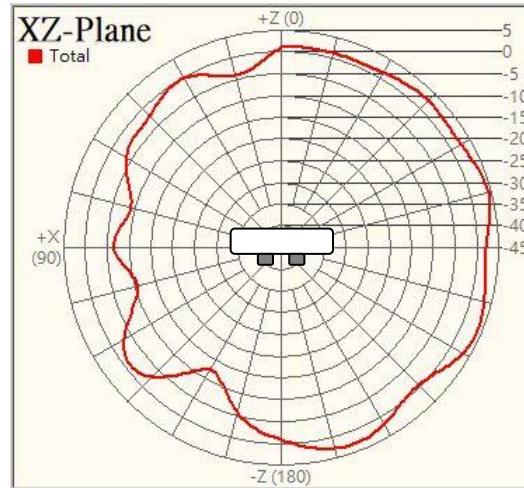
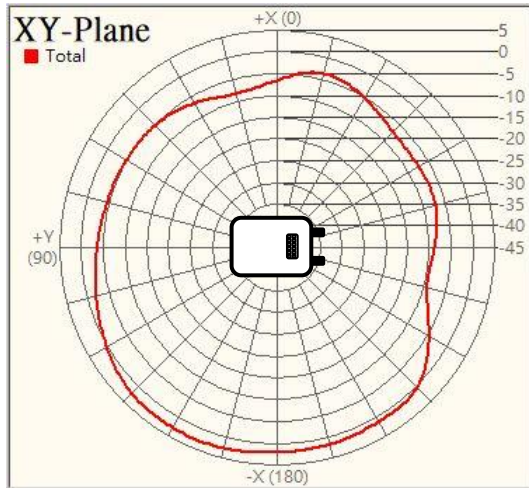


1575 MHz

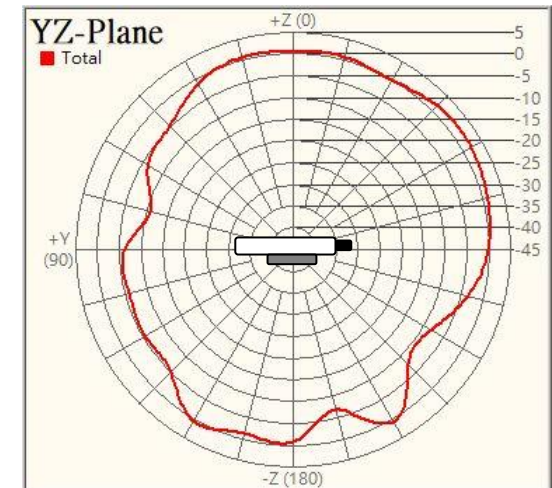
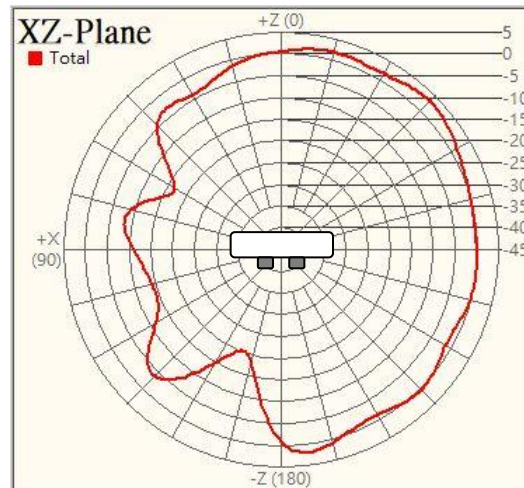
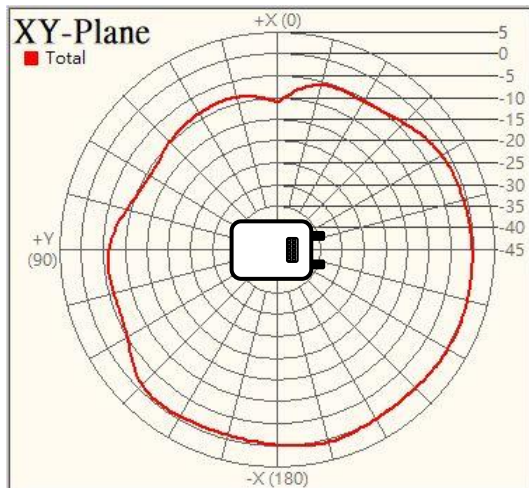


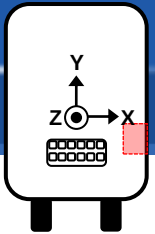


2450 MHz

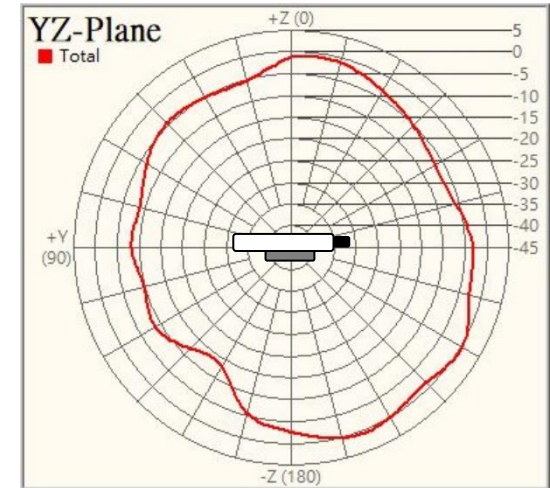
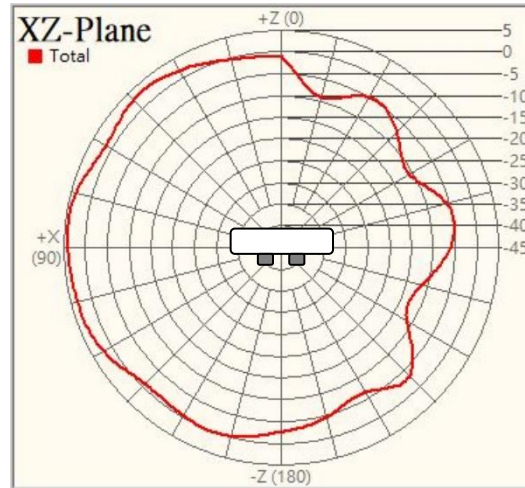
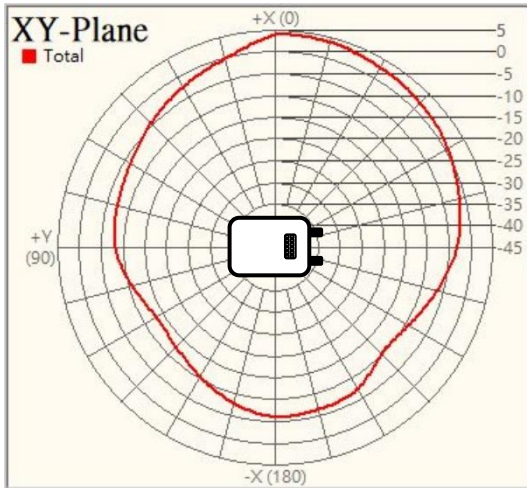


5500 MHz

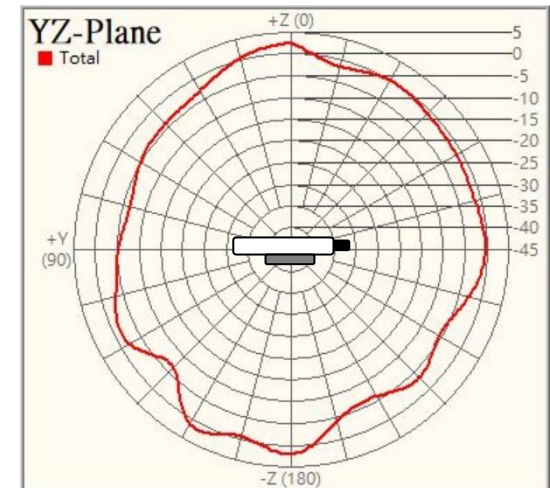
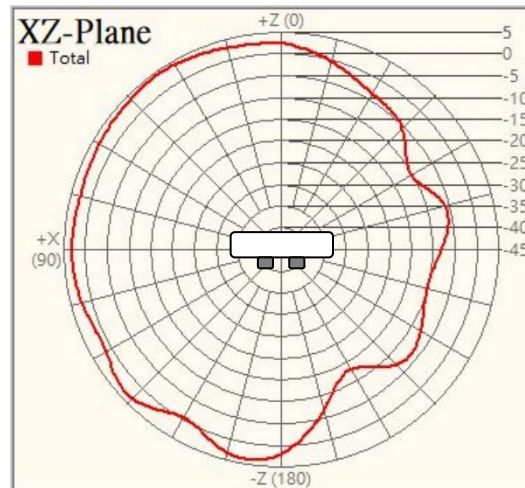
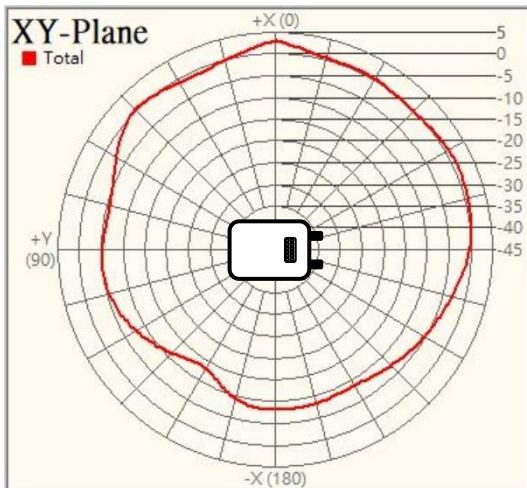


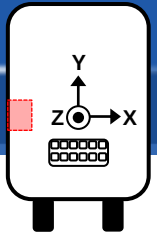


2450 MHz

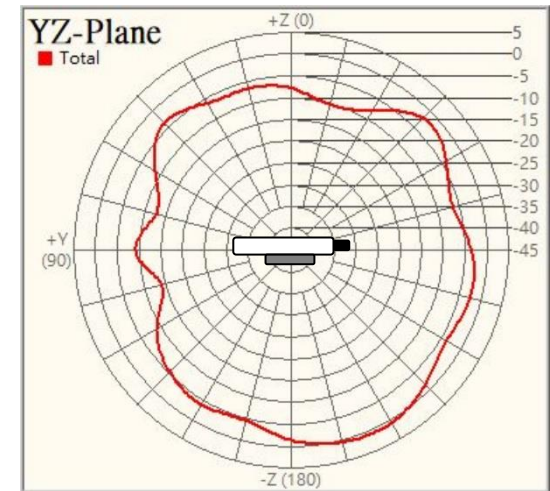
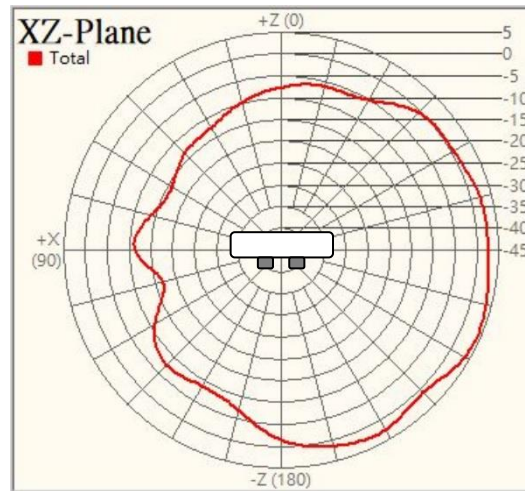
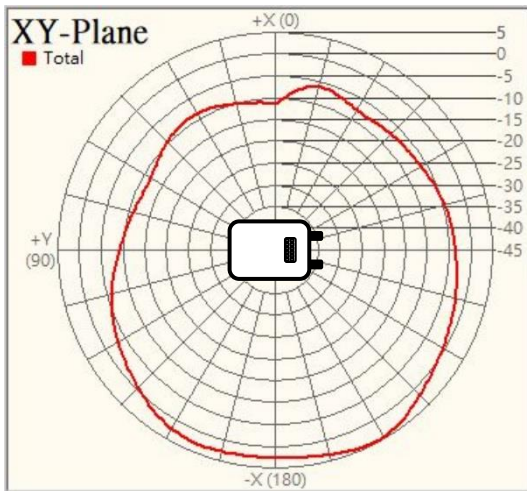


5500 MHz

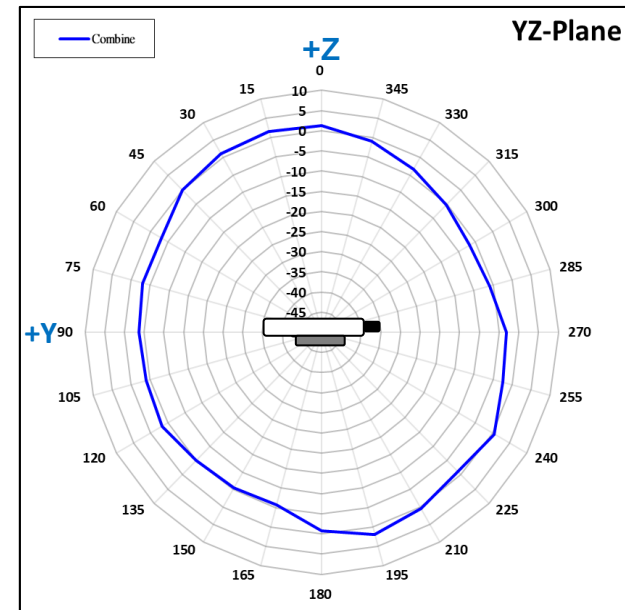
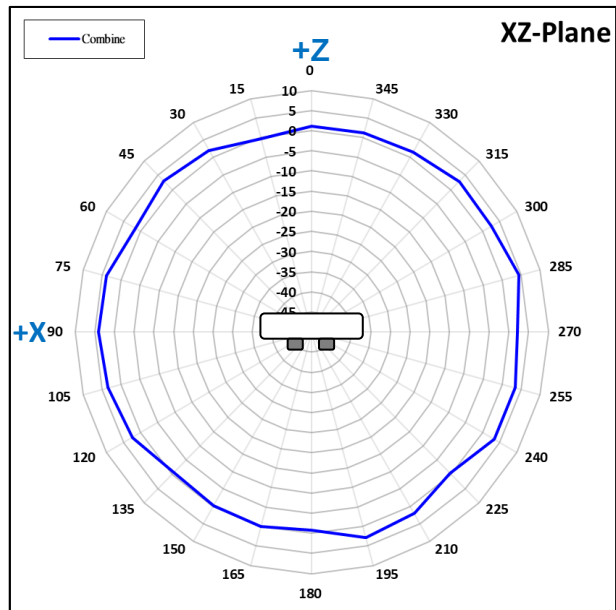
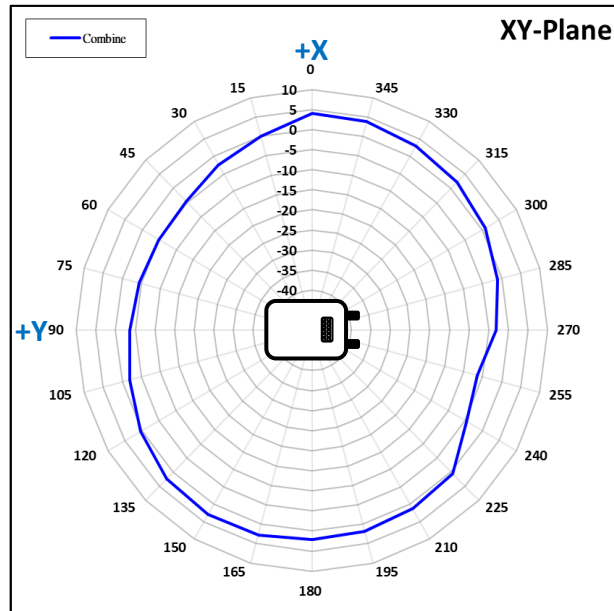
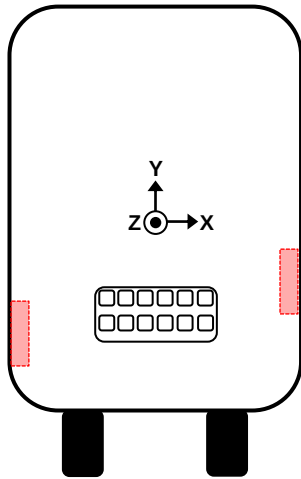




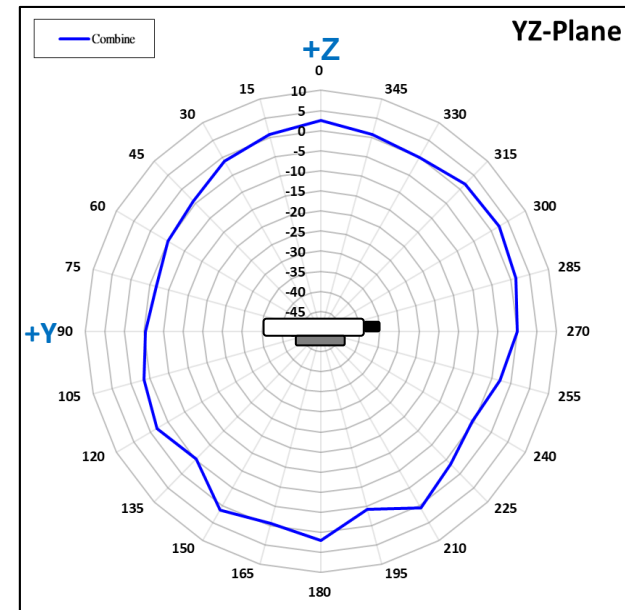
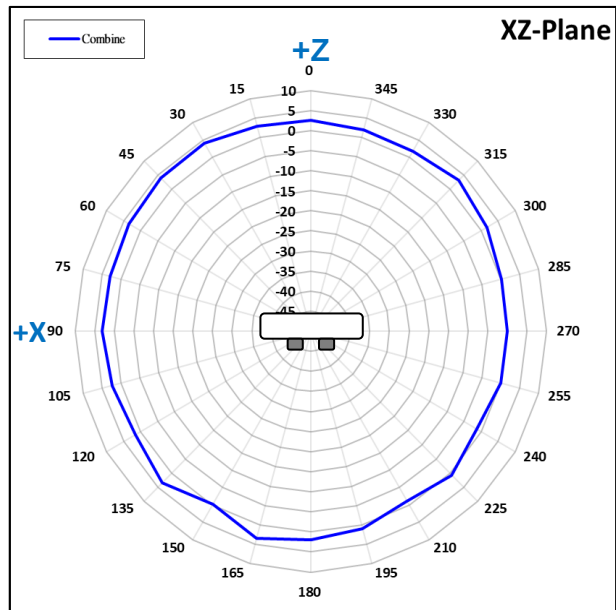
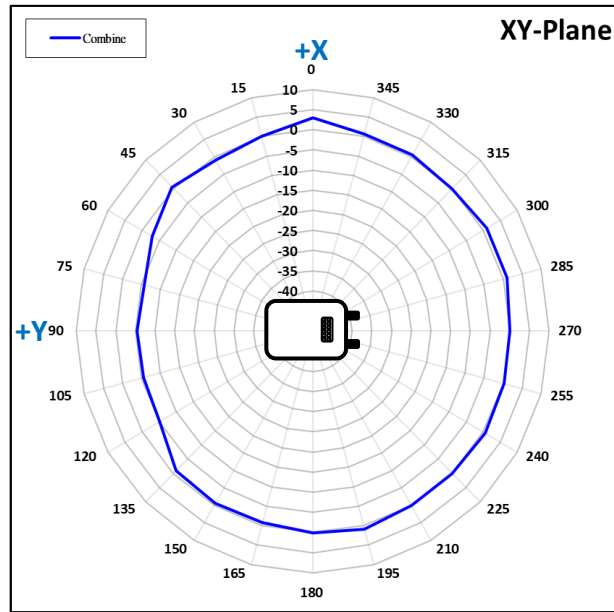
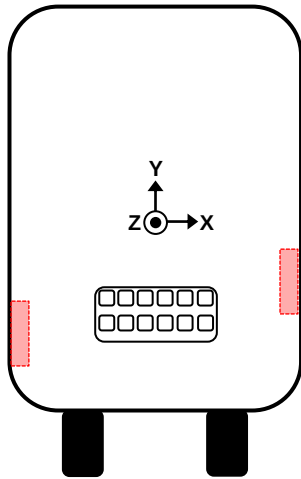
2450 MHz



Combine Pattern – WiFi 2G @ 2.45 GHz

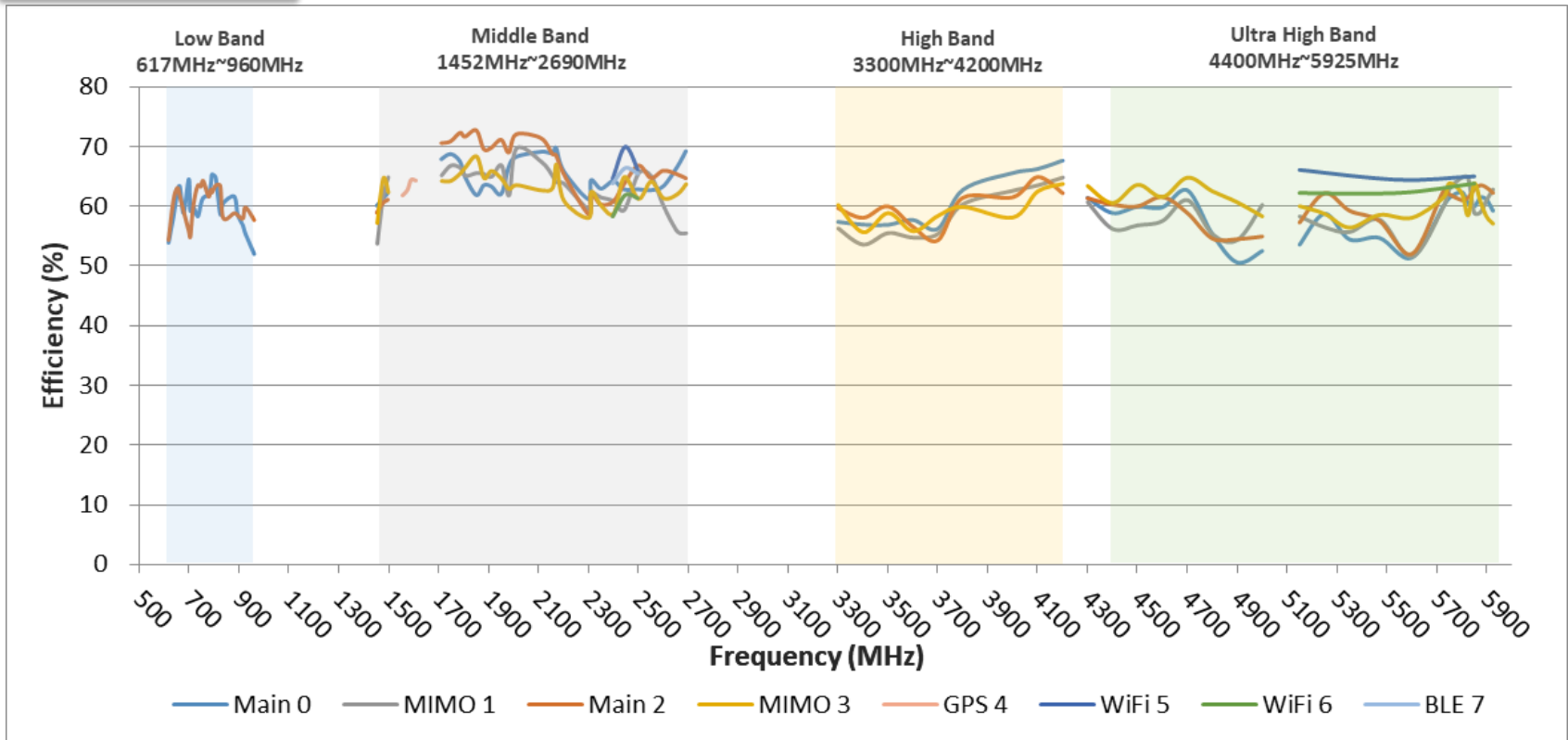


Combine Pattern – WiFi 5G @ 5.55 GHz



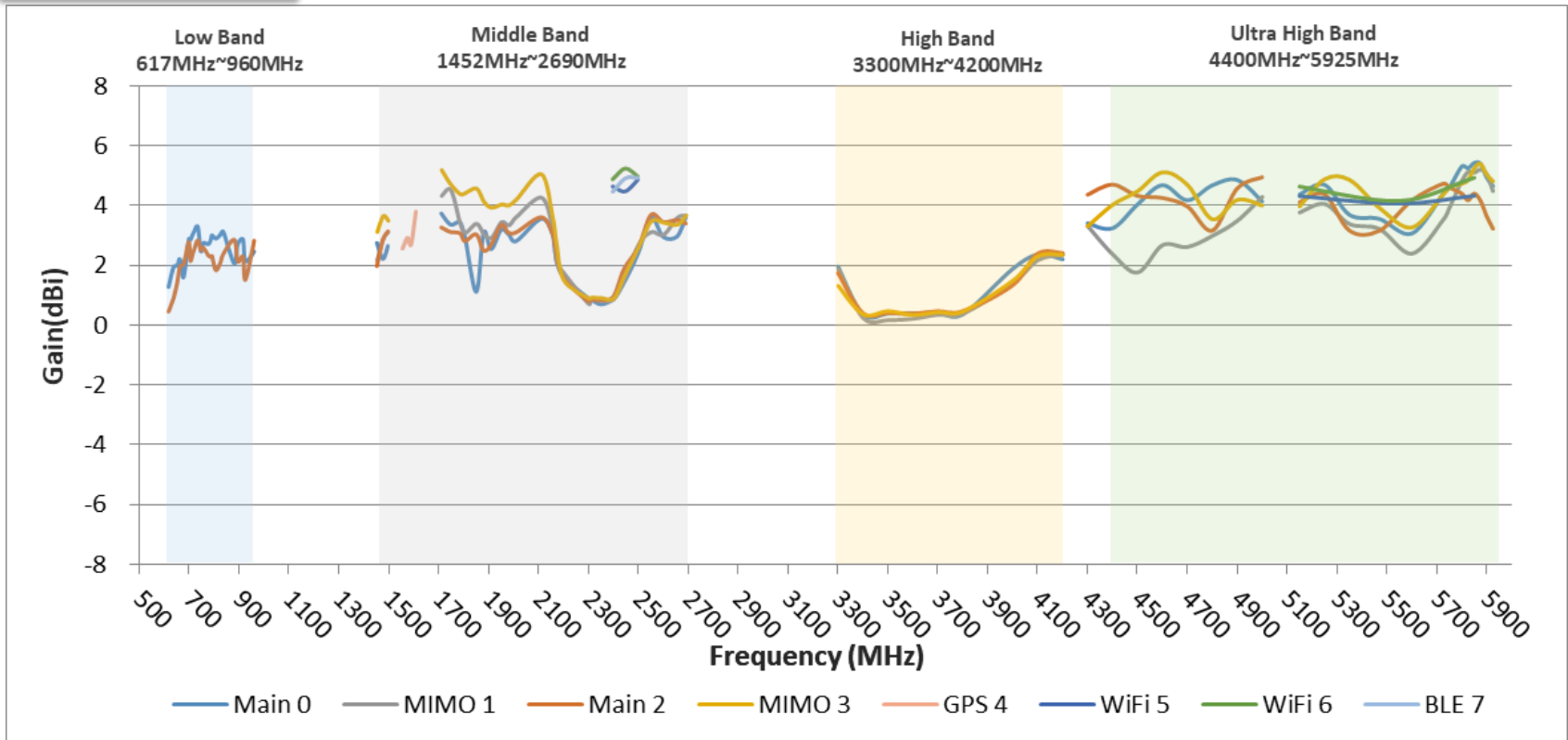
Antenna Efficiency and Gain

Efficiency



Antenna Efficiency and Gain

Gain



Antenna Efficiency and Gain

Antenna Performance				
Freq. (MHz)	Main Ant0		Main Ant2	
	Efficiency (%)	Peak Gain (dBi)	Efficiency (%)	Peak Gain (dBi)
617	53.9	1.28	54.4	0.45
637	58.4	1.95	61.2	0.91
652	62.3	1.99	63.1	1.45
662	63.3	2.21	61.7	1.97
677	58.9	1.61	59.2	2.05
698	64.5	2.89	55.9	2.79
704	59.2	2.85	54.9	2.16
716	59.9	3.08	60.2	2.46
734	58.3	3.30	63.5	2.84
746	60.3	2.48	63.2	2.52
756	61.4	2.75	64.2	2.60
777	62.0	2.72	61.6	2.33
787	63.8	2.89	62.7	2.29
791	65.3	3.01	62.3	2.32
806	64.7	2.90	63.5	1.85
824	58.7	3.02	63.4	2.08
836	60.5	3.13	58.0	2.38
880	61.6	2.07	58.8	2.87
894	58.6	2.71	58.5	2.14
915	56.8	2.87	57.9	2.29
925	55.4	2.14	59.8	1.52
960	52.0	2.47	57.7	2.83

Antenna Performance				
Freq. (MHz)	Main Ant0		Main Ant2	
	Efficiency (%)	Peak Gain (dBi)	Efficiency (%)	Peak Gain (dBi)
1452	60.1	2.76	58.9	1.98
1475	61.3	2.22	60.5	2.87
1496	62.3	2.65	61.1	3.14
1710	67.9	3.74	70.5	3.28
1747	68.7	3.37	70.8	3.12
1785	67.5	3.44	72.2	3.08
1805	64.9	2.94	71.6	2.82
1850	61.9	1.12	72.6	3.05
1880	63.5	3.10	69.5	2.50
1910	63.3	2.55	69.7	2.70
1950	62.0	3.20	71.0	3.35
1980	66.6	3.04	68.9	3.09
2010	68.3	2.82	71.9	3.11
2110	69.1	3.56	71.3	3.62
2155	68.9	3.06	68.7	3.09
2170	69.8	2.24	68.5	2.52
2200	65.9	1.62	65.4	1.58
2300	61.2	0.90	58.7	0.80
2310	64.4	0.87	62.0	0.86
2350	62.9	0.70	60.3	0.84
2400	64.2	0.89	60.8	0.97
2442	62.8	1.43	63.7	1.89
2500	62.8	2.44	66.8	2.61
2550	62.7	3.60	64.7	3.70
2600	63.3	2.96	65.9	3.46
2655	66.6	2.97	65.3	3.53
2690	69.2	3.63	64.6	3.41

Antenna Efficiency and Gain

Antenna Performance				
Freq. (MHz)	Main Ant0		Main Ant2	
	Efficiency (%)	Peak Gain (dBi)	Efficiency (%)	Peak Gain (dBi)
3300	57.4	1.97	59.7	1.75
3400	56.9	0.35	58.1	0.40
3500	56.9	0.39	60.0	0.41
3600	57.7	0.40	56.6	0.39
3700	56.2	0.42	54.3	0.47
3800	62.7	0.36	61.4	0.47
4000	65.5	1.89	61.5	1.34
4100	66.2	2.37	64.9	2.40
4200	67.6	2.21	62.2	2.42
4300	61.4	3.42	61.3	4.37
4400	58.8	3.25	60.3	4.71
4500	59.9	4.04	60.0	4.34
4600	59.8	4.69	61.5	4.26
4700	62.6	4.18	58.9	3.98
4800	55.3	4.68	54.6	3.17
4900	50.6	4.86	54.5	4.59
5000	52.5	4.14	55.0	4.96

Antenna Performance				
Freq. (MHz)	Main Ant0		Main Ant2	
	Efficiency (%)	Peak Gain (dBi)	Efficiency (%)	Peak Gain (dBi)
5150	53.6	4.38	57.3	4.12
5250	58.7	4.70	62.1	4.39
5350	54.4	3.69	59.2	3.17
5470	54.7	3.56	57.6	3.17
5600	51.4	3.07	52.1	4.18
5725	59.9	4.40	62.4	4.74
5750	61.4	4.60	62.0	4.62
5800	62.4	5.31	61.0	4.41
5825	60.6	5.25	61.4	4.19
5850	59.9	5.43	62.8	4.41
5875	61.4	5.40	63.5	4.17
5900	61.0	4.94	63.1	3.65
5925	59.2	4.66	62.2	3.23



Antenna Efficiency and Gain

Antenna Performance				
Freq. (MHz)	MIMO Ant1		MIMO Ant3	
	Efficiency (%)	Peak Gain (dBi)	Efficiency (%)	Peak Gain (dBi)
1452	53.7	2.17	57.2	3.10
1475	61.8	2.88	64.6	3.63
1496	64.9	3.12	62.3	3.48
1710	65.2	4.32	64.2	5.17
1747	66.9	4.51	64.2	4.68
1785	66.5	3.38	65.4	4.37
1805	65.1	3.09	66.4	4.40
1850	65.6	3.39	68.3	4.55
1880	65.4	3.03	64.6	4.11
1910	65.0	2.92	65.9	3.91
1950	66.9	3.44	64.5	4.02
1980	61.8	3.34	62.8	3.99
2010	69.8	3.62	63.5	4.19
2110	67.5	4.26	62.6	5.03
2155	65.1	3.21	63.0	3.60
2170	64.0	2.12	66.9	2.75
2200	63.9	1.75	60.9	1.49
2300	59.5	0.71	58.0	0.88
2310	62.2	0.86	62.4	0.91
2350	61.5	0.82	60.0	0.90
2400	60.9	0.87	58.8	0.89
2442	59.4	1.55	64.8	1.63
2500	65.6	2.70	61.2	2.59
2550	65.1	3.11	64.1	3.46
2600	60.0	3.03	61.3	3.42
2655	55.7	3.59	62.0	3.35
2690	55.5	3.67	63.7	3.65

Antenna Performance				
Freq. (MHz)	MIMO Ant1		MIMO Ant3	
	Efficiency (%)	Peak Gain (dBi)	Efficiency (%)	Peak Gain (dBi)
3300	56.3	1.87	60.2	1.30
3400	53.5	0.24	55.6	0.35
3500	55.5	0.18	58.8	0.46
3600	54.7	0.22	55.8	0.33
3700	55.4	0.36	58.4	0.43
3800	60.4	0.40	59.8	0.45
4000	62.6	1.40	58.1	1.47
4100	63.6	2.18	62.5	2.29
4200	64.9	2.36	63.7	2.34
4300	60.7	3.32	63.3	3.29
4400	56.2	2.37	60.5	4.01
4500	56.8	1.76	63.5	4.47
4600	57.5	2.68	61.5	5.10
4700	61.1	2.61	64.7	4.68
4800	55.3	2.99	62.5	3.53
4900	54.3	3.49	60.6	4.18
5000	60.2	4.29	58.3	3.99

Antenna Efficiency and Gain

Antenna Performance				
Freq. (MHz)	MIMO Ant1		MIMO Ant3	
	Efficiency (%)	Peak Gain (dBi)	Efficiency (%)	Peak Gain (dBi)
5150	58.3	3.77	60.0	3.96
5250	56.5	4.05	58.7	4.87
5350	55.7	3.38	56.4	4.85
5470	57.8	3.22	58.5	3.91
5600	51.5	2.39	58.0	3.25
5725	59.8	3.52	61.4	4.35
5750	62.9	3.91	63.8	4.59
5800	64.9	4.82	62.1	4.72
5825	64.8	5.12	58.4	4.84
5850	58.9	5.10	63.8	5.23
5875	59.0	5.20	60.7	5.38
5900	61.1	5.05	58.2	5.01
5925	62.8	4.48	57.0	4.80

Antenna Efficiency and Gain

Antenna Performance		
Freq. (MHz)	GPS Ant4	
	Efficiency (%)	Peak Gain (dBi)
1555	61.9	2.55
1575	62.8	2.91
1590	64.4	2.68
1610	64.2	3.79

Antenna Performance				
Freq. (MHz)	WiFi Ant5		WiFi Ant6	
	Efficiency (%)	Peak Gain (dBi)	Efficiency (%)	Peak Gain (dBi)
2400	64.7	4.63	58.3	4.89
2450	69.9	4.48	61.9	5.25
2500	66.1	4.84	61.4	4.98
5150	66.1	4.33	62.2	4.65
5500	64.5	4.08	62.3	4.17
5850	65.1	4.34	63.8	4.94

Antenna Performance		
Freq. (MHz)	BLE Ant7	
	Efficiency (%)	Peak Gain (dBi)
2400	63.7	4.45
2450	66.5	4.92
2500	65.5	4.93