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Antenna Proposal for Lyra(EVT-2) project

2022-04-22



Contents

- ❖ Antenna proposal
- ❖ Antenna placement
- ❖ Measurement data

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Antenna proposal

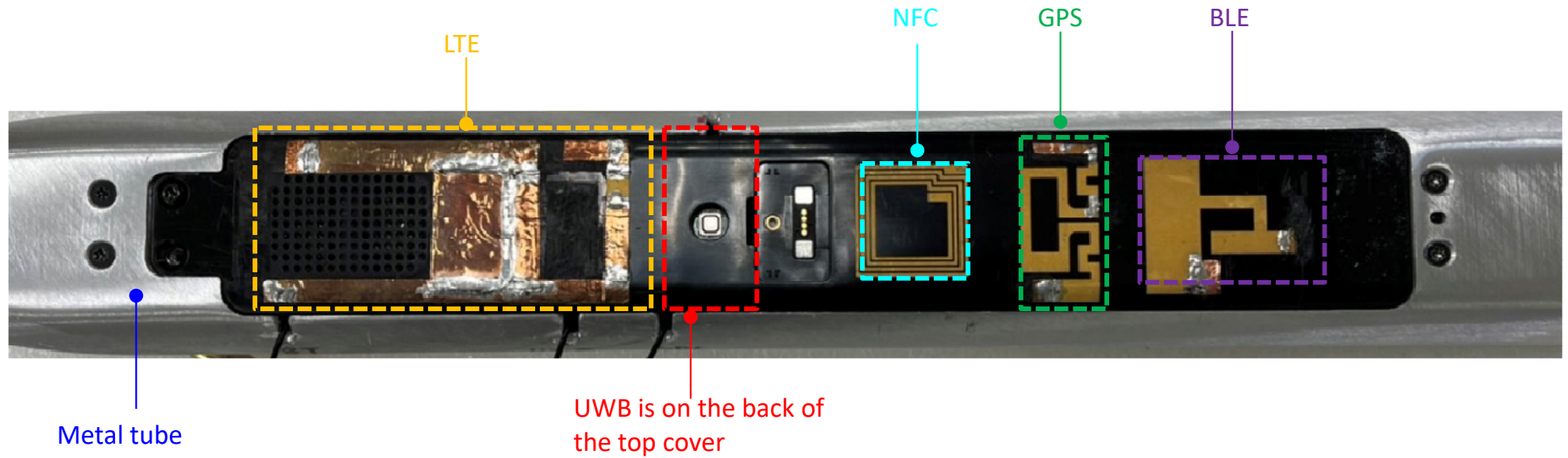


Antenna Proposal	
Wireless Function	■ LTE antenna * 1 ■ BT antenna * 1 ■ GPS antenna * 1 ■ UWB antenna * 1 ■ NFC antenna * 1
Antenna type	■ LDS Antenna * 5
Measurement data	
Return loss	< -10 dB
Isolation	< -15 dB
Peak Gain	■ LTE < 4.31 dBi ■ BT < 4.9 dBi ■ GPS < 2.68 dBi ■ UWB < 6.88 dBi
Efficiency	■ LTE > 40.73 % ■ BT > 41.55 % ■ GPS > 40.25% ■ UWB > 50.49 %

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Antenna placement

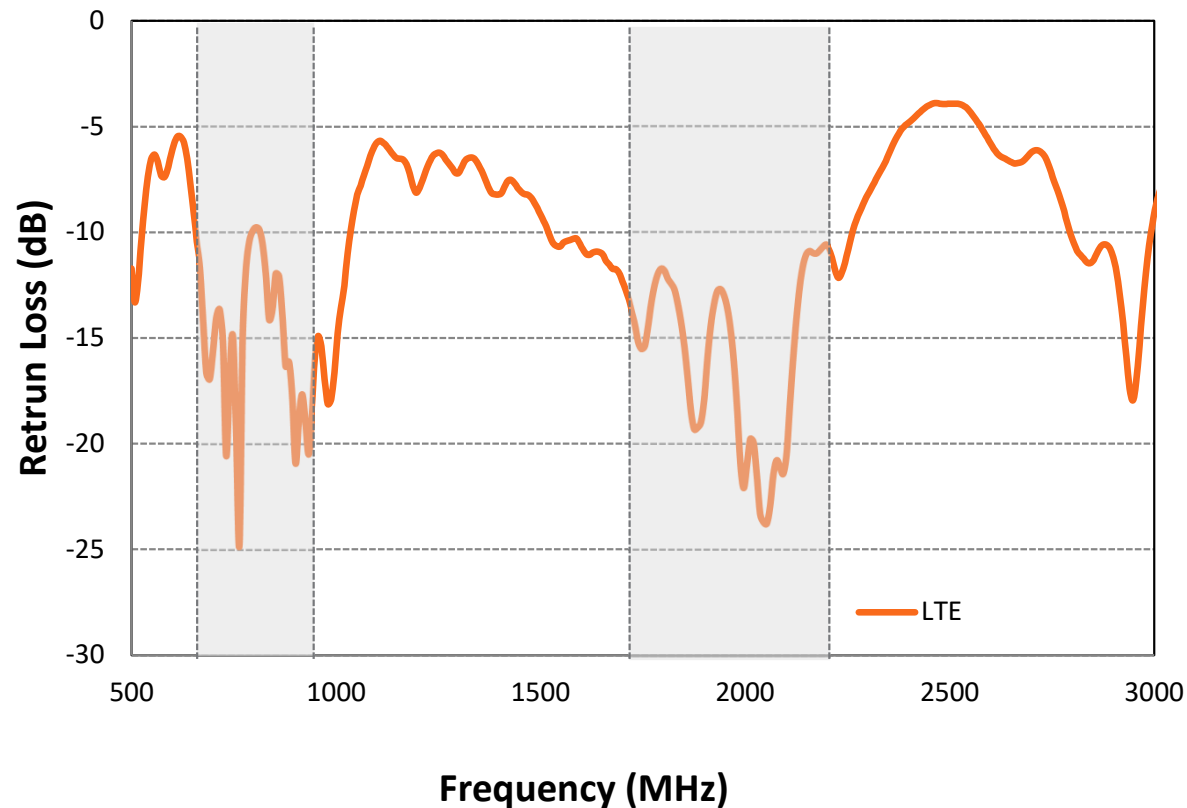


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 - S-parameter
 - Radiation pattern
 - Gain table

Measurement data

S-parameter : Return loss(LTE)



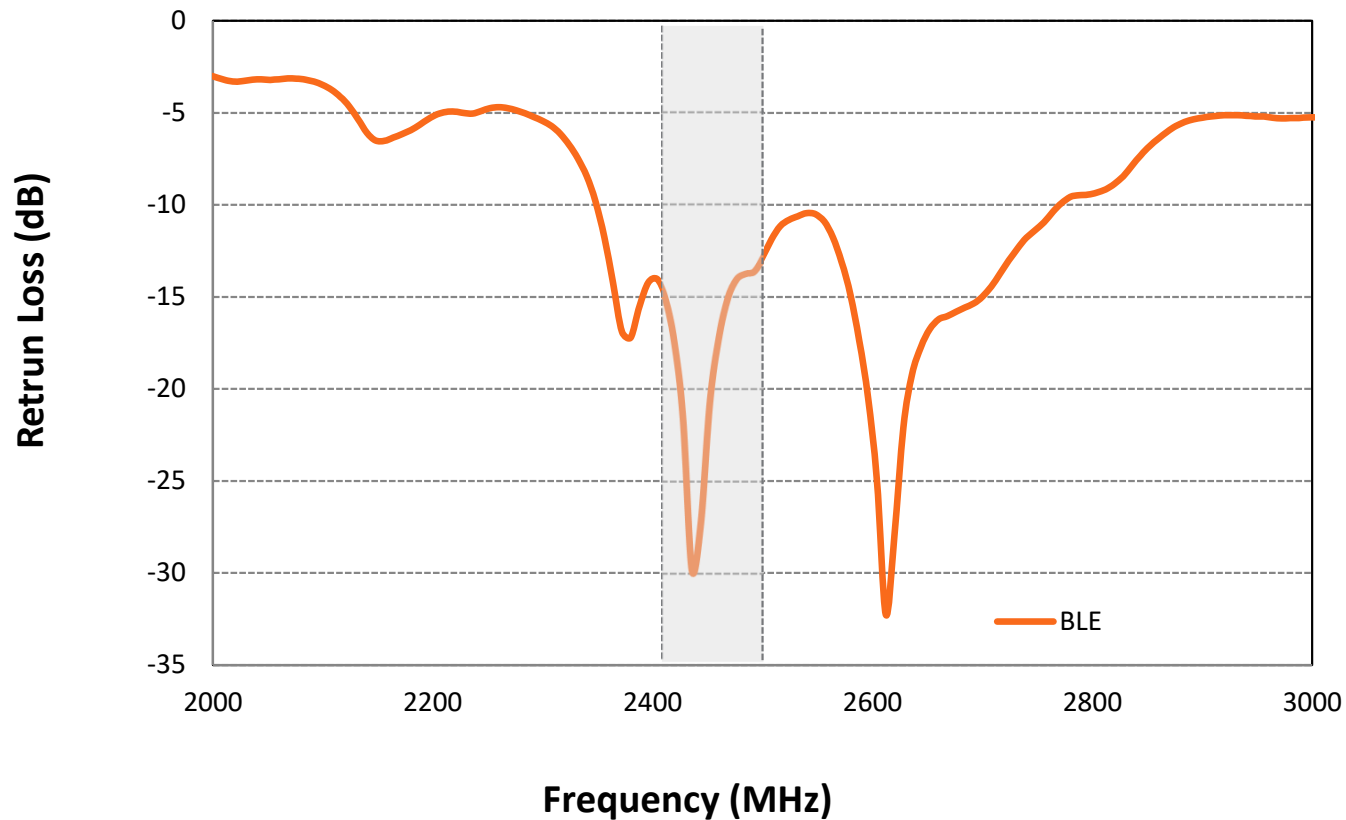
Frequency (MHz)	LTE
699	-16.94
777	-14.95
786	-11.72
824	-10.53
848	-13.63
880	-16.32
894	-17.77
1710	-12.73
1755	-15.52
1850	-14.25
1910	-15.99
1930	-13.41
1990	-20.91
2170	-10.99

Return Loss table

Unit: dB

Measurement data

S-parameter : Return loss(BT)



Frequency (MHz)	BT
2400	-14.23
2450	-27.23
2500	-12.84

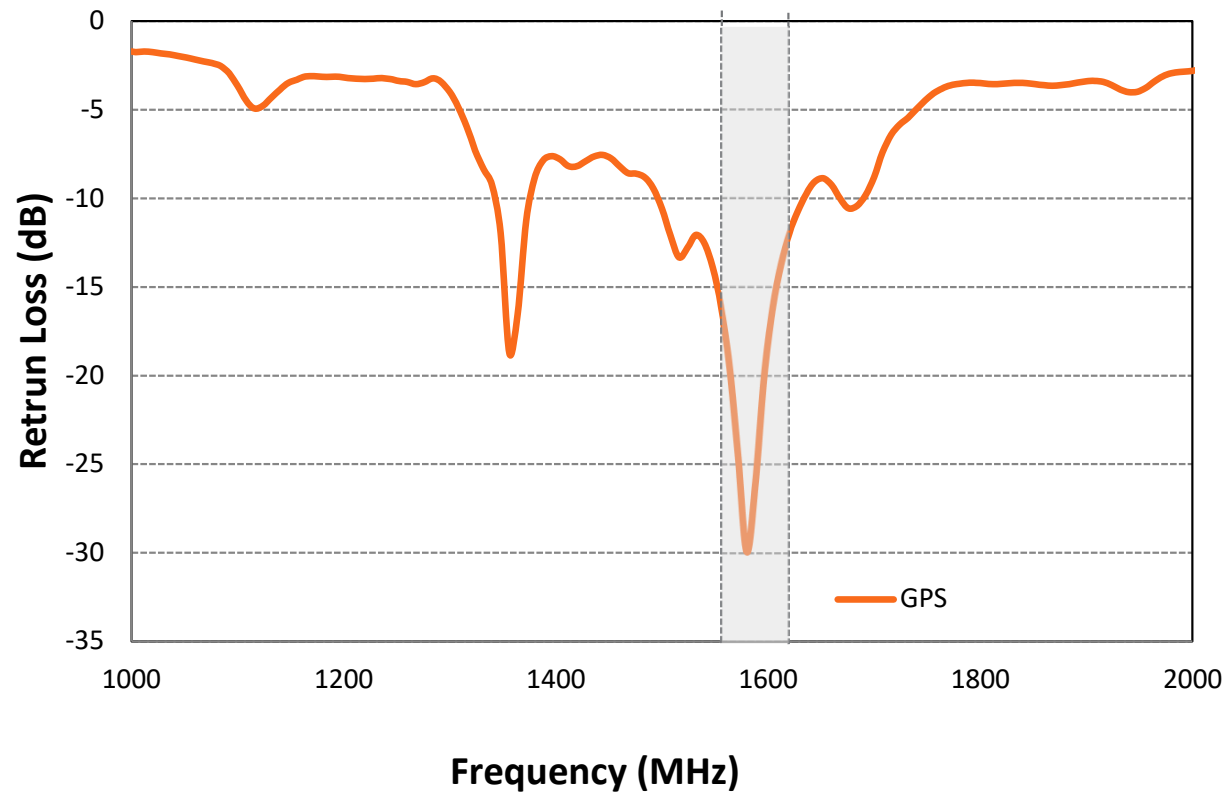
Return Loss table

Unit: dB

Unit: dB

Measurement data

S-parameter : Return loss(GPS)



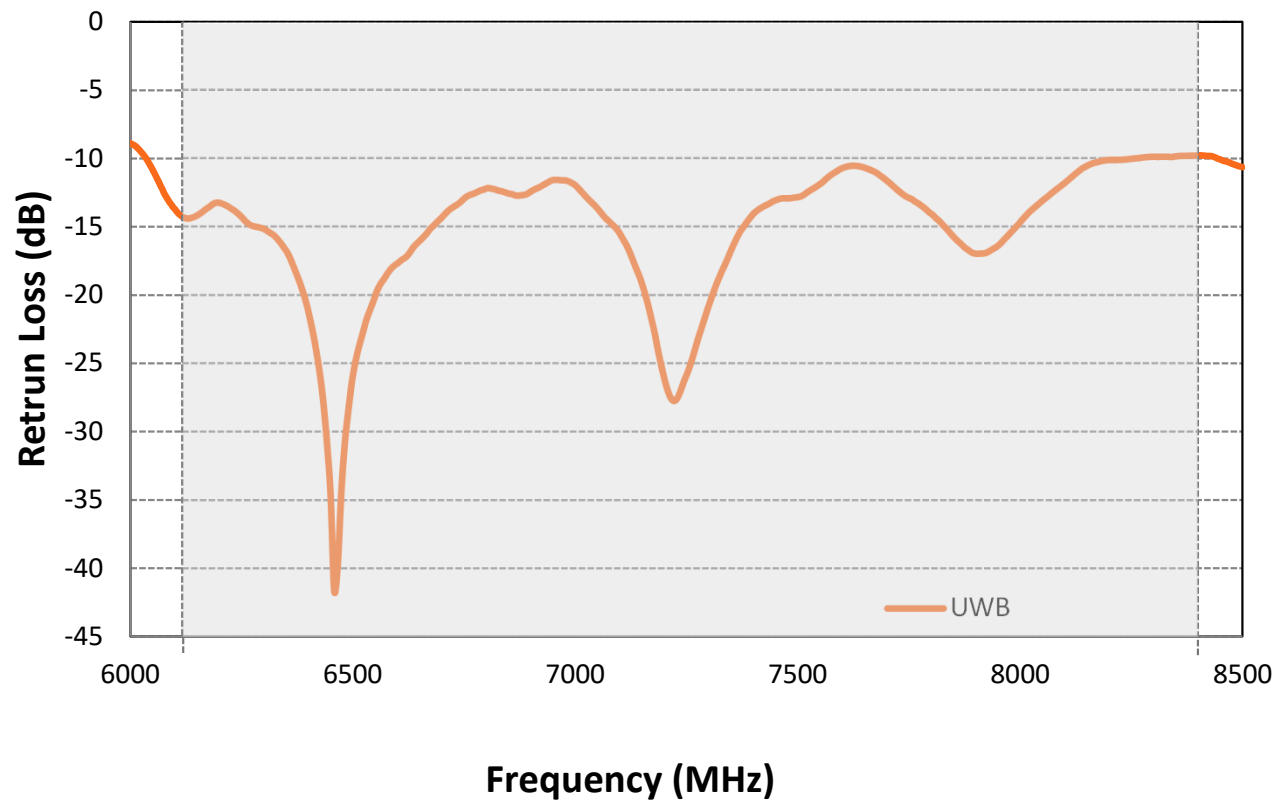
Frequency (MHz)	GPS
1550	-13.92
1575	-24.52
1605	-16.25

Return Loss table

Unit: dB

Measurement data

S-parameter : Return loss(UWB)

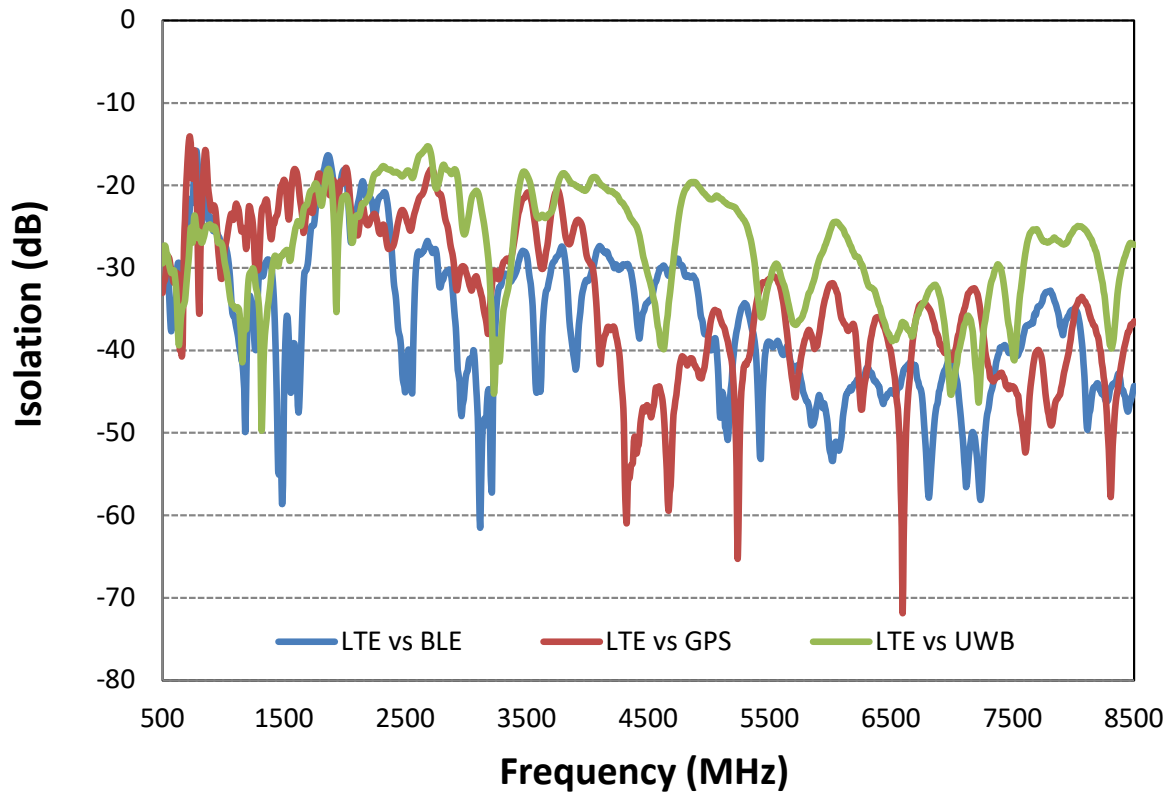


Frequency (MHz)	UWB
6245	-14.06
6405	-21.51
6525	-22.81
6725	-13.65
6875	-12.74
6885	-12.70
6925	-12.07
7000	-11.86
7125	-16.91
7200	-25.40
7300	-20.87
7500	-12.86
7700	-11.63
7900	-16.98

Return Loss table Unit: dB

Measurement data

S-parameter: Isolation



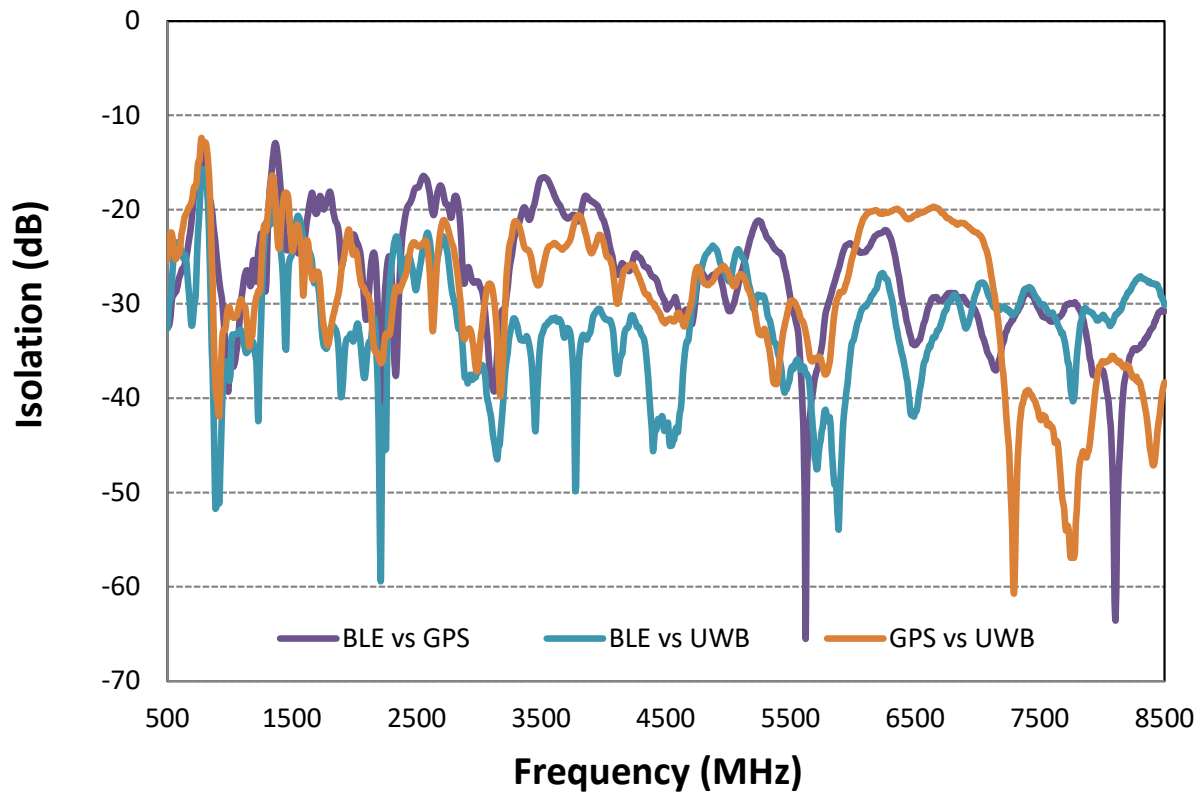
Frequency (MHz)	LTE to BT	LTE to GPS	LTE to UWB
699	-30.12	-20.81	-32.62
894	-28.55	-18.39	-31.20
1710	-23.79	-22.05	-24.73
1990	-26.03	-27.45	-26.92
2200	-27.56	-22.79	-21.15
1550	-18.25	-19.60	-21.39
1605	-21.36	-24.81	-21.47
2400	-41.34	-23.46	-29.14
2450	-40.35	-19.04	-27.18
2450	-42.88	-18.44	-24.78
6240	-29.84	-27.43	-18.36
7000	-37.71	-24.25	-18.53
8240	-45.07	-23.65	-18.53

Isolation table

Unit: dB

Measurement data

S-parameter: Isolation



Frequency (MHz)	BT to GPS	BT to UWB	GPS to UWB
1550	-21.30	-32.31	-19.24
1605	-20.24	-32.21	-18.78
2400	-24.70	-51.52	-39.84
2450	-32.88	-36.90	-32.80
2500	-19.65	-28.15	-26.60
6240	-22.69	-34.00	-24.81
7000	-40.01	-45.84	-35.79
8240	-24.64	-20.66	-21.71

Isolation table

Unit: dB

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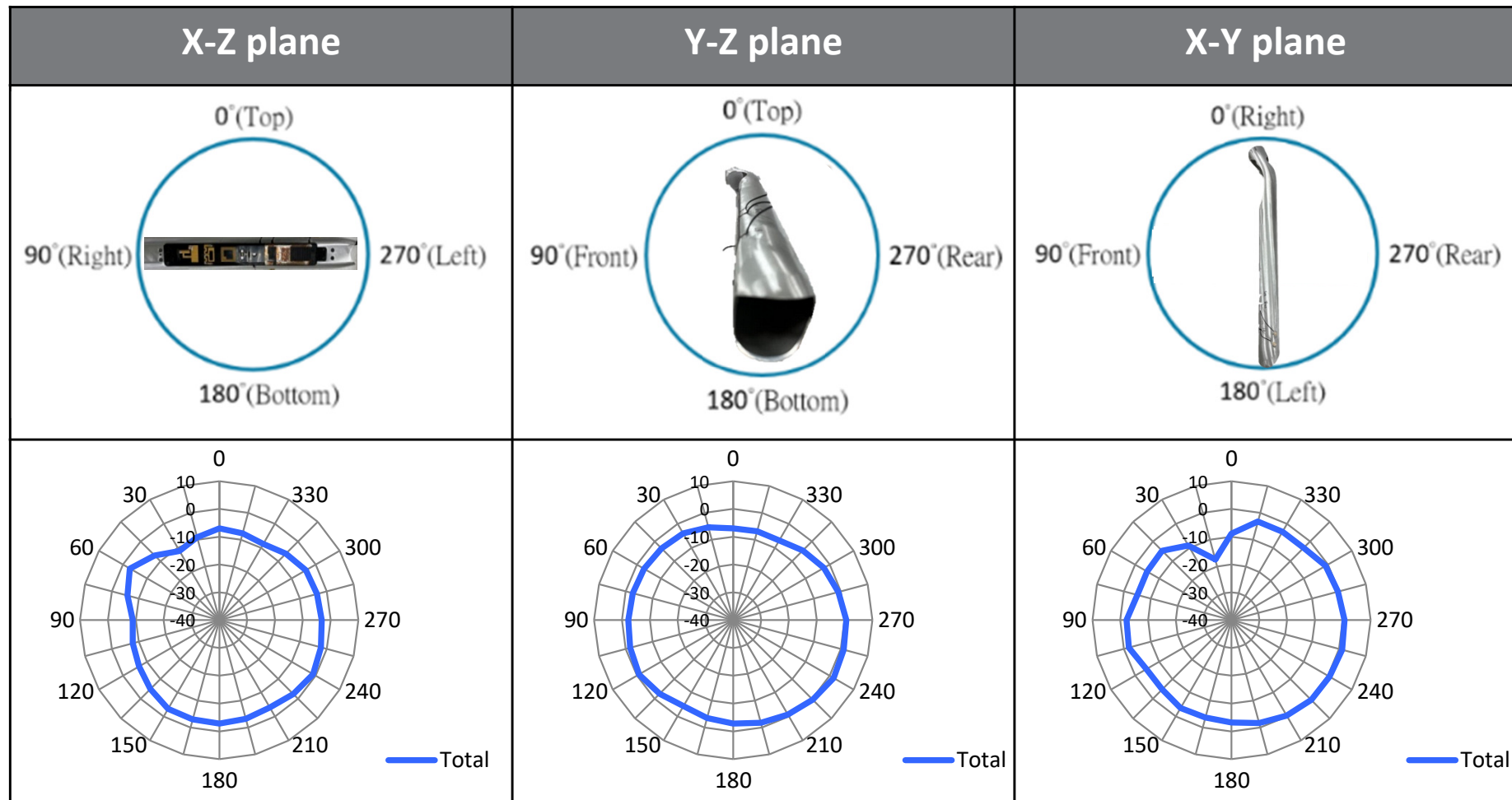
Measurement data

Radiation pattern - DUT orientation setting



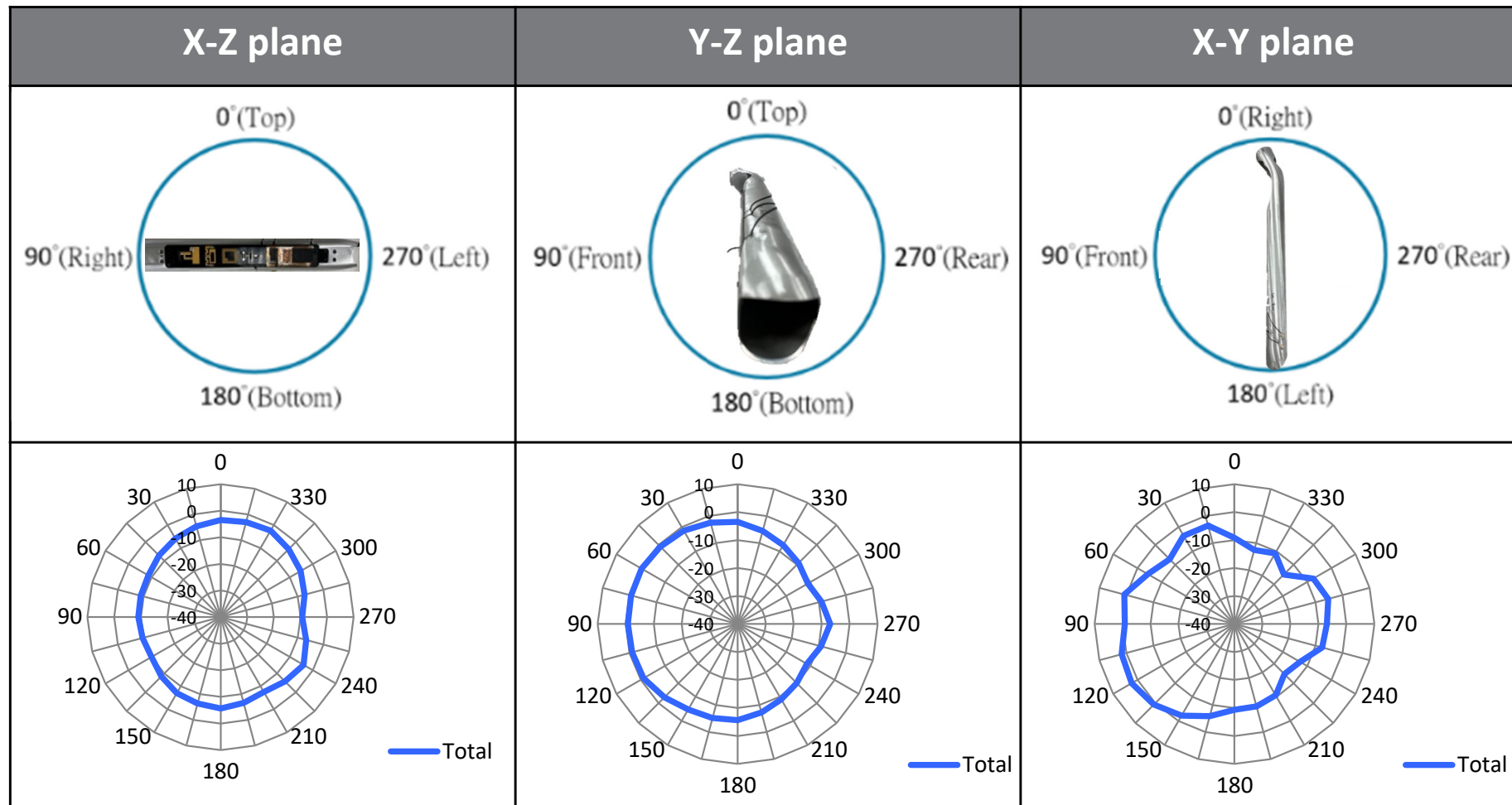
Measurement data

Radiation pattern – Low Band(777MHz)



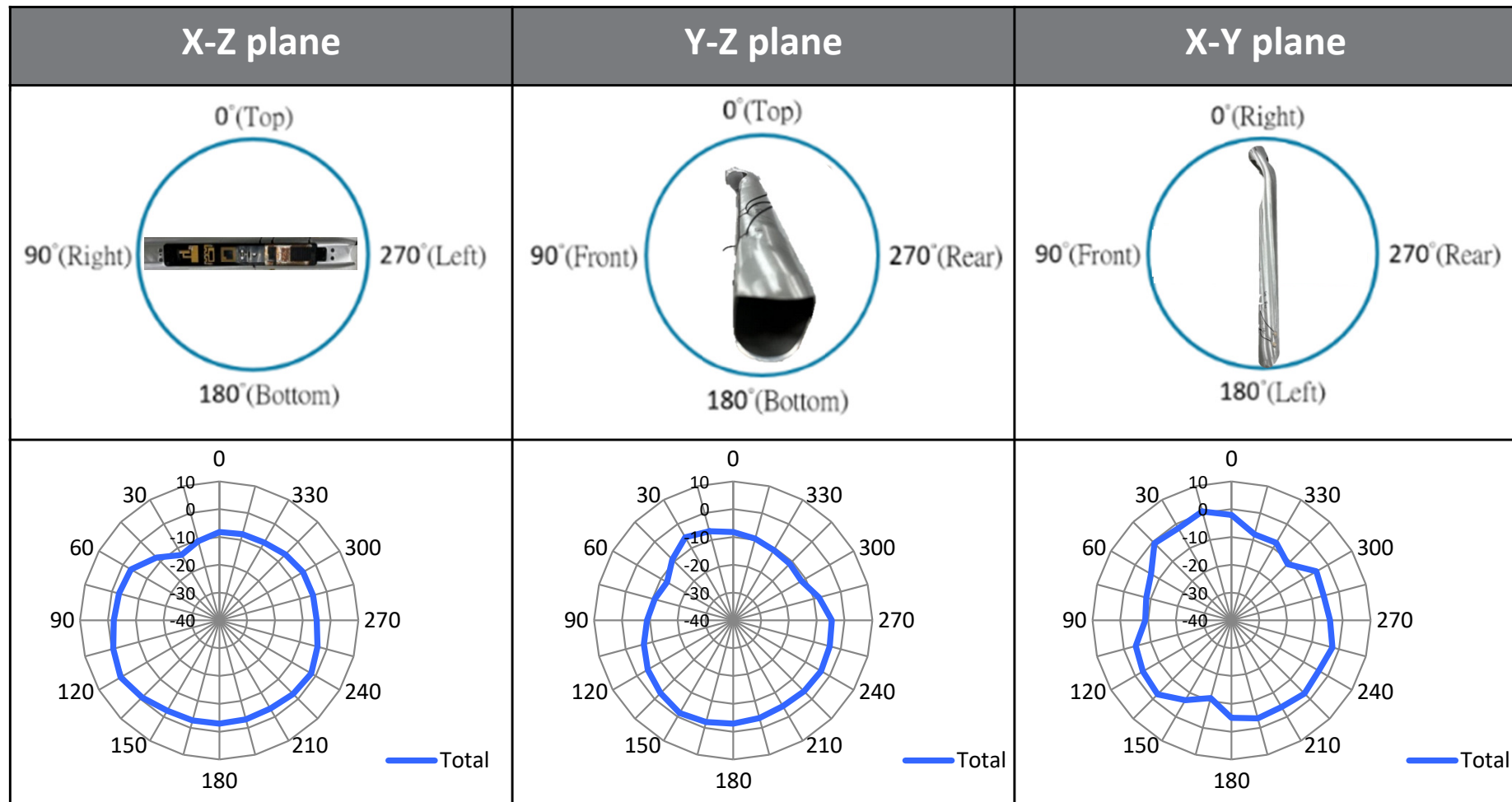
Measurement data

Radiation pattern – High Band(1880MHz)



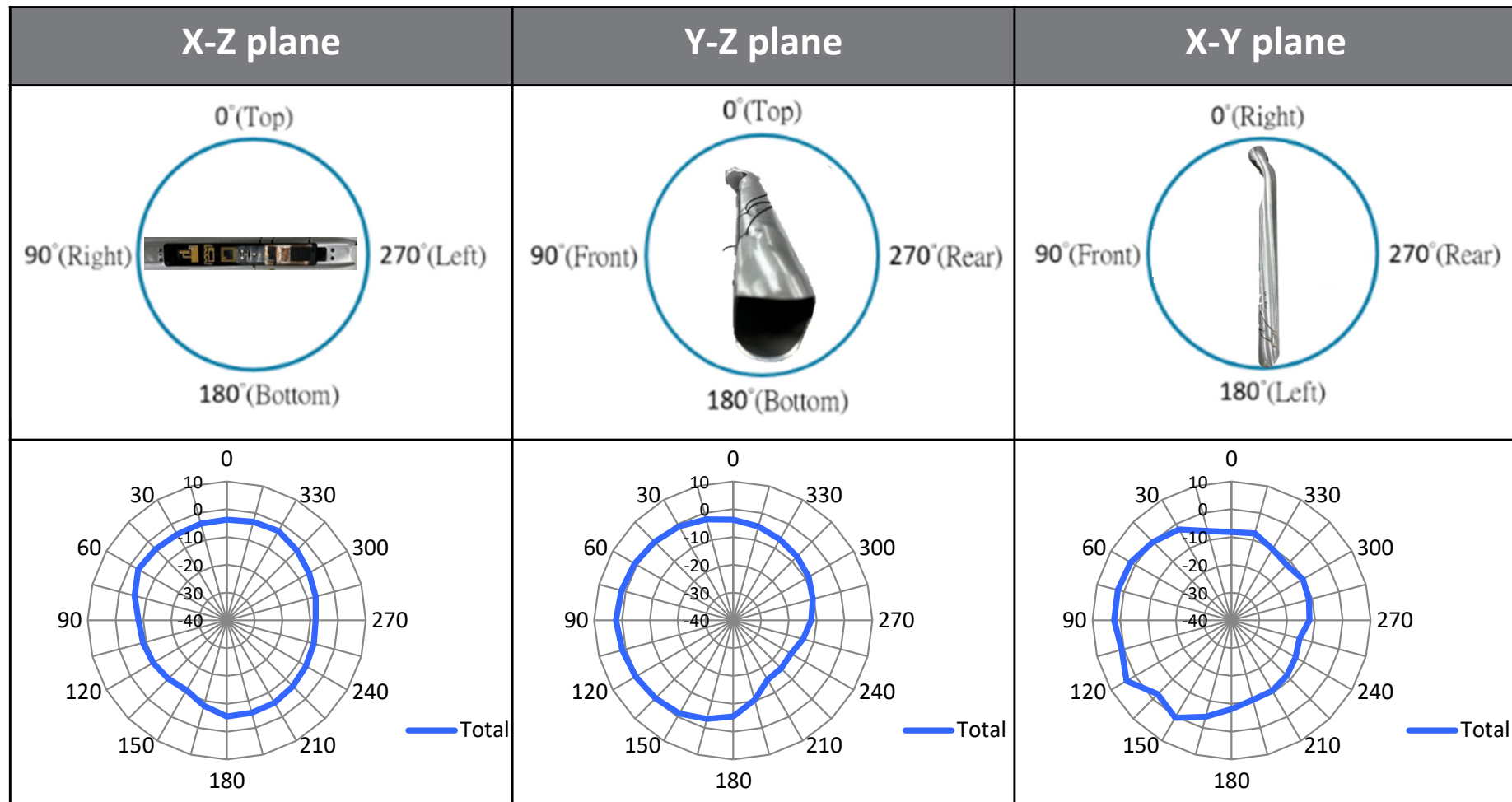
Measurement data

Radiation pattern – High Band(2170MHz)



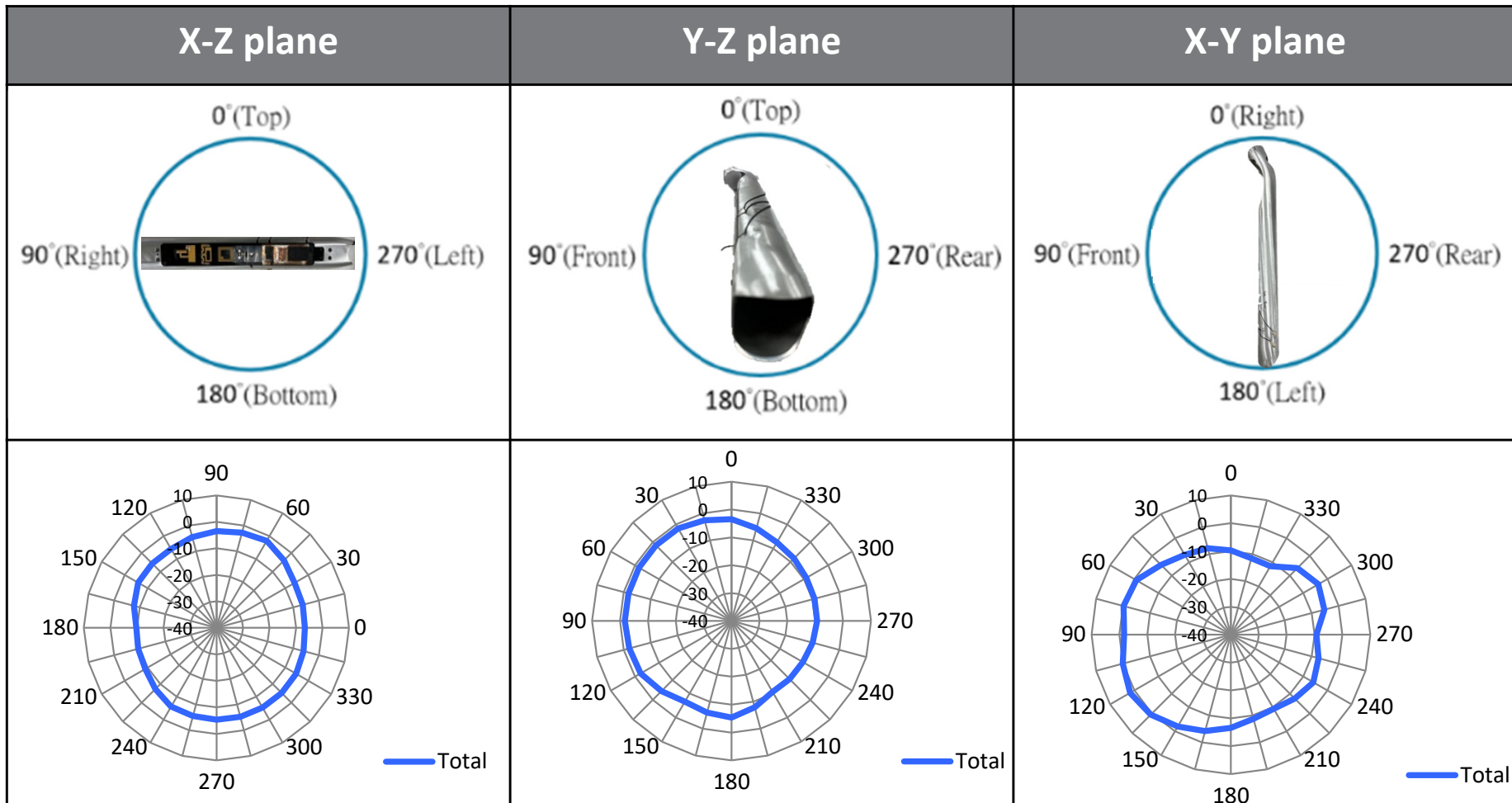
Measurement data

Radiation pattern – BT(2450MHz)



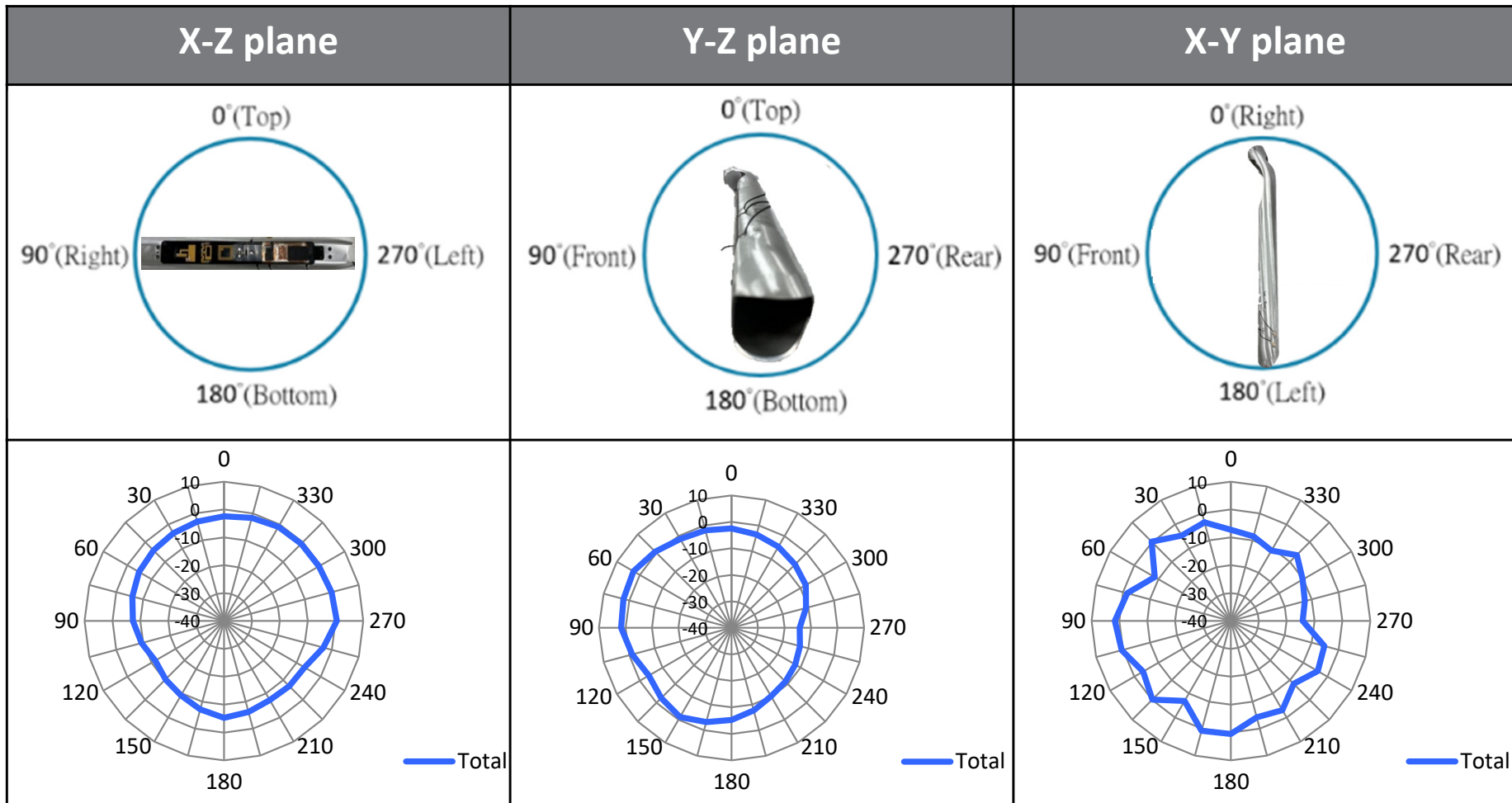
Measurement data

Radiation pattern – 1575MHz



Measurement data

Radiation pattern – UWB(7150MHz)



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Measurement data

❖ Gain table – LTE

Frequency (MHz)	XZ Plane		YZ Plane		XY Plane		E-total (dBi)	Efficiency (%)
	Peak Gain (dBi)	Average Gain (dBi)	Peak Gain (dBi)	Average Gain (dBi)	Peak Gain (dBi)	Average Gain (dBi)		
698	-2.64	-5.81	-1.54	-4.60	-3.53	-5.74	0.16	41.51
704	-2.27	-5.59	-0.85	-4.07	-2.72	-5.22	0.71	45.19
707	-2.08	-5.50	-0.52	-3.91	-2.34	-5.05	1.00	46.41
710	-1.90	-5.33	-0.23	-3.75	-2.07	-4.86	1.27	48.06
716	-1.72	-5.06	0.20	-3.44	-1.70	-4.51	1.70	51.32
729	-2.85	-5.74	0.33	-3.65	-1.69	-4.68	1.85	46.87
734	-3.58	-6.53	-0.27	-4.26	-2.14	-5.38	1.67	43.52
737	-3.74	-6.81	-0.59	-4.44	-2.43	-5.58	1.45	42.09
740	-3.63	-6.79	-0.67	-4.31	-2.45	-5.41	1.46	43.89
746	-3.09	-6.19	-0.14	-3.48	-1.61	-4.31	1.49	46.14
751	-2.75	-5.61	0.56	-2.75	-0.70	-3.37	2.12	54.67
756	-1.53	-5.06	1.28	-2.10	0.15	-2.58	2.77	63.53
777	-1.12	-4.40	1.66	-1.94	0.72	-2.33	3.03	68.49
782	-1.67	-4.48	1.32	-2.20	0.63	-2.60	2.71	65.30
787	-2.31	-4.62	0.93	-2.51	0.49	-2.88	2.33	61.76
791	-2.79	-4.78	0.59	-2.76	0.32	-3.11	1.99	58.74

Measurement data

❖ Gain table – LTE

Frequency (MHz)	XZ Plane		YZ Plane		XY Plane		E-total (dBi)	Efficiency (%)
	Peak Gain (dBi)	Average Gain (dBi)	Peak Gain (dBi)	Average Gain (dBi)	Peak Gain (dBi)	Average Gain (dBi)		
806	-3.22	-5.63	-1.10	-3.92	-0.94	-4.23	0.82	45.99
815	-3.76	-6.06	-1.74	-4.36	-1.85	-4.89	0.38	43.80
821	-4.06	-6.26	-1.88	-4.48	-2.27	-5.28	-0.08	41.45
824	-3.87	-6.33	-1.87	-4.47	-2.34	-5.42	0.00	41.72
832	-3.32	-6.42	-1.64	-4.35	-2.46	-5.72	0.62	41.70
836	-3.00	-6.37	-1.44	-4.20	-2.43	-5.76	1.13	44.12
847	-1.82	-5.82	-0.49	-3.42	-1.89	-5.36	1.63	42.92
849	-1.61	-5.72	-0.34	-3.30	-1.80	-5.28	1.86	44.04
862	-0.41	-4.92	0.89	-2.57	-0.84	-4.32	1.96	45.07
869	-0.12	-4.55	1.08	-2.30	-0.13	-3.53	1.78	44.68
880	-0.36	-4.62	0.77	-2.12	0.18	-3.06	1.88	47.32
881	-0.34	-4.62	0.77	-2.10	0.16	-3.05	1.86	47.45
894	0.01	-4.32	1.02	-1.81	0.51	-2.72	1.92	50.84
897	0.08	-4.15	0.96	-1.79	0.68	-2.49	1.99	52.54
915	-0.28	-4.00	1.20	-1.46	1.35	-1.39	2.01	60.77
925	-0.04	-3.97	1.02	-1.23	1.37	-1.13	1.92	64.04

Measurement data

❖ Gain table – LTE

Frequency (MHz)	XZ Plane		YZ Plane		XY Plane		E-total (dBi)	Efficiency (%)
	Peak Gain (dBi)	Average Gain (dBi)	Peak Gain (dBi)	Average Gain (dBi)	Peak Gain (dBi)	Average Gain (dBi)		
942	0.09	-3.61	1.25	-1.18	1.25	-1.11	2.57	66.21
960	-0.77	-3.79	0.96	-1.82	0.74	-1.79	2.20	58.04
1710	-1.99	-3.83	1.02	-2.50	-0.40	-3.44	1.76	41.42
1732	-2.02	-3.57	-0.16	-2.60	0.39	-3.08	2.24	47.51
1747	-1.61	-3.80	-0.36	-2.42	0.74	-3.05	3.32	49.83
1755	-1.28	-3.82	0.13	-2.14	1.14	-2.92	3.81	51.96
1785	-1.50	-4.42	1.02	-2.08	1.26	-3.14	3.44	48.27
1805	-2.04	-5.02	1.09	-2.39	1.19	-3.39	3.06	43.21
1842	-3.18	-6.17	1.58	-2.40	1.58	-3.76	3.44	41.80
1850	-3.67	-6.45	1.35	-2.56	1.35	-3.95	3.25	40.73
1880	-2.45	-5.91	-0.26	-3.82	2.44	-3.90	3.23	41.06
1900	-2.45	-5.30	-1.28	-4.76	3.35	-3.51	4.13	42.62
1910	-2.83	-5.15	-1.35	-5.10	3.54	-3.32	4.31	42.99
1920	-3.28	-5.22	-1.45	-5.15	3.52	-3.18	4.30	42.78
1930	-3.62	-5.51	-1.59	-5.15	3.27	-3.18	4.15	41.83
1950	-2.70	-4.75	-1.55	-5.16	3.00	-2.56	3.52	44.08

Measurement data

❖ Gain table – LTE

Frequency (MHz)	XZ Plane		YZ Plane		XY Plane		E-total (dBi)	Efficiency (%)
	Peak Gain (dBi)	Average Gain (dBi)	Peak Gain (dBi)	Average Gain (dBi)	Peak Gain (dBi)	Average Gain (dBi)		
1960	-1.27	-4.10	-1.00	-4.99	2.87	-2.26	3.09	47.56
1980	0.14	-3.18	-0.67	-4.58	3.19	-1.52	3.31	55.38
1990	0.31	-3.01	-0.31	-4.25	3.16	-1.25	3.24	57.66
2010	0.32	-3.29	-0.34	-4.06	2.12	-1.61	2.52	53.56
2040	0.35	-3.27	0.49	-4.05	1.90	-2.10	2.96	49.45
2070	0.11	-3.28	0.53	-4.39	0.63	-2.59	3.10	47.18
2110	0.12	-3.20	0.29	-4.38	0.18	-3.30	2.35	44.63
2132	-0.19	-3.39	0.15	-4.44	-0.63	-3.56	2.06	42.97
2140	0.01	-3.45	-0.10	-4.53	-0.93	-3.68	2.21	44.04
2155	0.76	-3.29	-0.72	-4.82	-1.32	-3.95	2.36	46.66
2170	0.94	-3.37	-1.46	-5.31	-1.72	-4.41	2.21	47.07

Measurement data

❖ Gain table – BT

Frequency (MHz)	XZ Plane		YZ Plane		XY Plane		E-total (dBi)	Efficiency (%)
	Peak Gain (dBi)	Average Gain (dBi)	Peak Gain (dBi)	Average Gain (dBi)	Peak Gain (dBi)	Average Gain (dBi)		
2400	-3.71	-5.82	0.13	-3.86	2.13	-3.43	3.22	41.55
2410	-3.16	-5.45	0.60	-3.46	2.70	-2.80	3.93	46.86
2420	-2.82	-5.21	1.20	-2.99	3.28	-2.26	4.56	51.69
2430	-2.71	-5.18	1.65	-2.70	3.54	-1.98	4.82	53.96
2440	-2.74	-5.35	1.96	-2.55	3.63	-1.88	4.90	54.18
2450	-2.90	-5.62	2.22	-2.49	3.64	-1.82	4.86	52.94
2460	-3.03	-5.85	2.48	-2.40	3.64	-1.79	4.80	52.06
2470	-3.18	-6.10	2.61	-2.37	3.53	-1.86	4.68	49.90
2480	-3.17	-6.20	2.87	-2.27	3.42	-1.85	4.57	48.73
2490	-3.23	-6.34	2.86	-2.34	3.23	-2.00	4.36	46.48
2500	-3.49	-6.56	2.78	-2.46	3.03	-2.20	4.12	44.03

Measurement data

❖ Gain table – GPS

Frequency (MHz)	XZ Plane		YZ Plane		XY Plane		E-total (dBi)	Efficiency (%)
	Peak Gain (dBi)	Average Gain (dBi)	Peak Gain (dBi)	Average Gain (dBi)	Peak Gain (dBi)	Average Gain (dBi)		
1550	-3.34	-5.99	0.39	-2.87	0.69	-3.71	2.29	40.25
1555	-3.00	-5.83	0.17	-3.03	0.91	-3.67	2.32	40.73
1560	-2.65	-5.66	-0.17	-3.30	1.10	-3.67	2.31	41.24
1565	-2.38	-5.56	-0.58	-3.64	1.30	-3.68	2.33	42.11
1570	-2.19	-5.46	-1.08	-4.09	1.50	-3.70	2.38	43.14
1575	-2.07	-5.40	-1.66	-4.58	1.74	-3.68	2.45	44.35
1580	-1.95	-5.35	-2.18	-5.07	1.93	-3.63	2.42	45.11
1585	-2.07	-5.43	-2.56	-5.53	2.02	-3.63	2.28	44.87
1590	-2.16	-5.49	-2.74	-5.84	2.11	-3.60	2.23	44.64
1595	-2.30	-5.57	-2.82	-6.04	2.18	-3.57	2.44	44.35
1600	-2.40	-5.65	-2.81	-6.15	2.20	-3.56	2.60	43.90
1605	-2.52	-5.82	-2.79	-6.22	2.11	-3.62	2.68	42.81

Measurement data

❖ Gain table -UWB

Frequency (MHz)	XZ Plane		YZ Plane		XY Plane		E-total (dBi)	Efficiency (%)
	Peak Gain (dBi)	Average Gain (dBi)	Peak Gain (dBi)	Average Gain (dBi)	Peak Gain (dBi)	Average Gain (dBi)		
6480	1.73	-2.96	1.33	-2.52	2.64	-2.05	4.97	54.19
6530	1.86	-2.77	1.28	-2.67	1.76	-2.26	4.80	55.87
6580	2.80	-2.17	1.46	-2.45	2.47	-1.87	4.62	62.98
6630	2.57	-2.90	-0.20	-3.55	2.10	-2.87	4.19	54.40
6680	2.83	-2.71	0.36	-3.31	2.37	-2.77	4.15	51.87
6730	3.81	-1.84	0.66	-2.48	3.46	-2.09	5.65	61.53
6780	3.79	-1.94	0.18	-2.65	4.15	-2.13	5.90	61.71
6830	2.55	-2.74	-0.29	-3.39	3.87	-2.83	5.55	54.58
6880	2.87	-2.31	0.14	-2.99	2.61	-2.84	5.97	57.21
6930	2.22	-2.14	1.15	-2.67	1.74	-2.79	5.45	58.27
6980	1.37	-2.82	1.47	-2.87	1.37	-3.70	5.02	52.99
7030	1.41	-2.82	1.99	-2.66	1.41	-3.63	5.27	54.61
7080	1.03	-2.92	2.99	-2.08	1.19	-3.47	5.86	57.87
7130	0.51	-3.64	2.75	-2.34	1.89	-3.54	4.98	53.84
7180	0.05	-3.41	2.76	-2.19	2.76	-2.62	5.31	55.58
7230	0.15	-3.16	2.93	-2.15	2.93	-2.11	6.31	58.93

Measurement data

❖ Gain table -UWB

Frequency (MHz)	XZ Plane		YZ Plane		XY Plane		E-total (dBi)	Efficiency (%)
	Peak Gain (dBi)	Average Gain (dBi)	Peak Gain (dBi)	Average Gain (dBi)	Peak Gain (dBi)	Average Gain (dBi)		
7280	0.19	-2.94	2.74	-2.59	2.29	-2.04	6.00	59.74
7330	0.17	-3.26	2.96	-2.35	2.77	-2.06	4.76	57.52
7380	0.24	-3.77	2.71	-2.80	2.71	-2.08	4.96	53.16
7430	1.00	-4.02	3.45	-2.68	2.50	-2.18	5.61	54.99
7480	1.33	-4.69	4.56	-2.71	2.58	-2.27	5.43	52.38
7530	2.43	-4.75	4.91	-2.37	3.51	-1.76	5.62	50.49
7580	2.91	-4.62	5.94	-1.53	4.25	-1.30	5.50	53.74
7630	2.56	-4.64	6.21	-1.39	4.18	-1.21	5.18	52.42
7680	3.49	-3.95	6.49	-1.25	4.25	-0.96	5.24	54.81
7730	3.66	-3.42	6.02	-1.37	4.41	-0.58	4.96	55.16
7780	3.93	-3.04	5.45	-1.45	4.35	-0.38	5.01	58.36
7830	3.82	-3.30	4.75	-1.54	4.58	-0.41	5.10	60.42
7880	2.87	-3.37	4.64	-1.51	4.64	-0.48	5.20	58.25
7930	2.54	-3.07	5.21	-1.28	5.21	-0.51	5.61	60.18
7980	2.20	-3.08	5.91	-0.92	5.91	-0.15	6.88	66.19
8030	1.74	-3.06	4.65	-1.82	4.65	-0.94	6.55	56.27

Measurement data

❖ Gain table - UWB

Frequency (MHz)	XZ Plane		YZ Plane		XY Plane		E-total (dBi)	Efficiency (%)
	Peak Gain (dBi)	Average Gain (dBi)	Peak Gain (dBi)	Average Gain (dBi)	Peak Gain (dBi)	Average Gain (dBi)		
8080	3.26	-2.59	4.59	-1.79	4.59	-0.71	6.42	64.45
8130	0.70	-3.24	4.10	-2.21	4.10	-0.74	5.73	61.67
8180	-1.16	-3.54	4.98	-2.18	4.98	-0.14	5.72	58.51
8240	0.51	-3.58	5.80	-2.18	5.80	0.45	5.96	59.42