

Antenna Composite Gain Test Report

1. Test Information

Equipment	EMT
Brand Name	Nokia
Model Name	B19
Applicant	Nokia
Manufacturer	Nokia

2. Testing Location

Testing Location	
AOT Kunshan Lab	ADD: 289 Jinghua Road, Shipai, Bacheng Town, Kunshan City, Jiangsu Province

Test Condition	Test Engineer	Test Environment (°C / %)	Test Date
Radiated	Changgan Lai	20-24 / 45-60	05.24.2024~05.24.2024

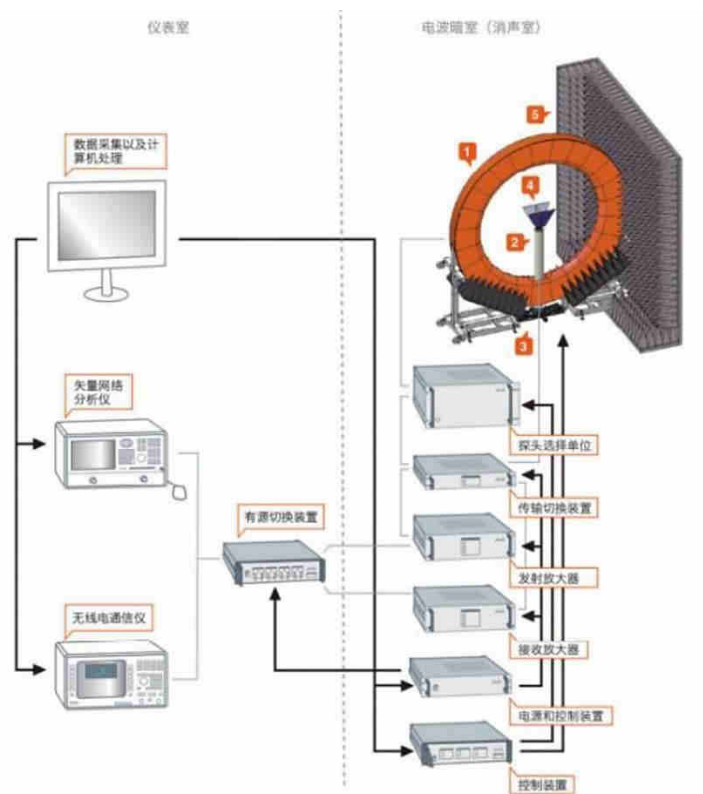
3. Test Frequency

Band (MHz)	Test Frequency (MHz)
2400-2500	2400/2450/2500
5150-5850	5150/5500/5850
5925-7125	5925/6500/7125

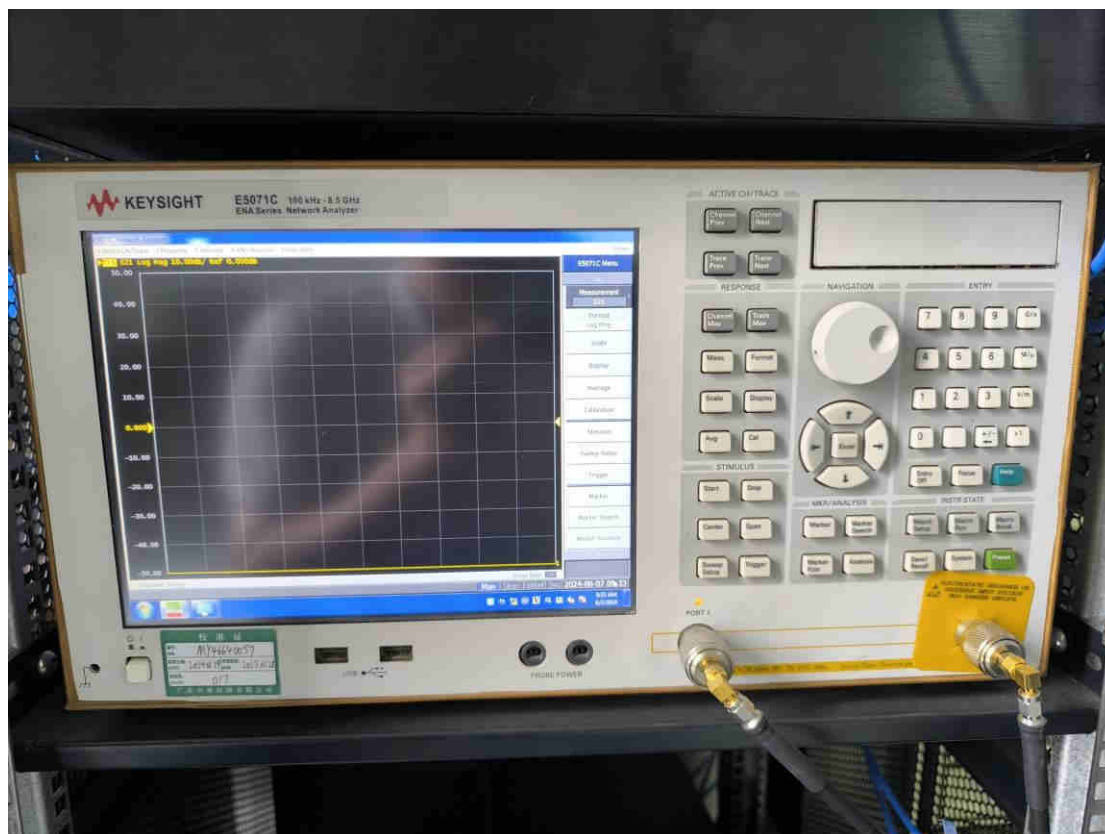
4. Antenna Information

Ant. Position	Brand Name	Ant. Type	Connector
Antenna 1 (2.4G)	Nokia	Dipole	I-PEX
Antenna 2 (2.4G)	Nokia	Dipole	I-PEX
Antenna 3 (2.4G)	Nokia	Dipole	I-PEX
Antenna 4 (2.4G)	Nokia	Dipole	I-PEX
Antenna 5 (5G)	Nokia	Dipole	I-PEX
Antenna 6 (5G)	Nokia	Dipole	I-PEX
Antenna 7 (5G)	Nokia	Dipole	I-PEX
Antenna 8 (5G)	Nokia	Dipole	I-PEX
Antenna A (6G)	Nokia	Dipole	I-PEX
Antenna B (6G)	Nokia	Dipole	I-PEX
Antenna C (6G)	Nokia	Dipole	I-PEX
Antenna D (6G)	Nokia	Dipole	I-PEX

5. Test Configuration



6. Reference Calibration



CALIBRATION PASS

CAL.DATA: 2024.1.29

NEXT CAL.DATA: 2025.1.29

7. Test Method

The “great circle” cut method, whereby the Measurement Antenna remains fixed and the EUT is rotated about two axes in sequential order. The radiated RF performance of the Equipment Under Test (EUT) is measured by sampling the radiated transmit power of the mobile at various locations surrounding the device. A three-dimensional characterization of the 'transmit' performance of the EUT is pieced together by analyzing the data from the spatially distributed measurements.

Data points taken every 2 degrees in the theta and in the phi axes are deemed sufficient to fully characterize the EUT's Far-Field radiation pattern and total radiated power. All of the measured power values will be integrated.

8. Measured Values and Calculation of Correlated /

Uncorrelated Gains

Antenna Peak Gain Table (Ant. Position: 2.4G Ant.1~4)

Band (MHz)	2400-2500		
Frequency (MHz)	2400	2450	2500
Ant.1 Max Gain (dBi)	1.42	1.80	1.52
Ant.2 Max Gain (dBi)	1.69	1.66	1.12
Ant.3 Max Gain (dBi)	1.52	1.57	1.42
Ant.4 Max Gain (dBi)	1.72	1.38	1.27
Max Gain (dBi)	1.72	1.80	1.52

Antenna Peak Gain Table (Ant. Position: 5G Ant.5~8)

Band (MHz)	5150-5850		
Frequency (MHz)	5150	5500	5850
Ant.5 Max Gain (dBi)	2.37	3.44	3.13
Ant.6 Max Gain (dBi)	2.53	1.86	2.73
Ant.7 Max Gain (dBi)	2.71	2.05	2.66
Ant.8 Max Gain (dBi)	2.75	3.33	3.71
Max Gain (dBi)	2.75	3.44	3.71

Antenna Peak Gain Table (Ant. Position: 6G Ant.A~D)

Band (MHz)	5925-7125		
Frequency (MHz)	5925	6500	7125
Ant.A Max Gain (dBi)	3.59	2.44	3.34
Ant.B Max Gain (dBi)	3.60	2.60	3.50
Ant.C Max Gain (dBi)	3.52	2.52	3.32
Ant.D Max Gain (dBi)	3.12	2.78	3.66
Max Gain (dBi)	3.60	2.78	3.66

Because the antennas are fixed in location within the device the directional antenna gain for MIMO is calculated over a sphere using the raw spatial data taken at 2 degree steps of theta and 10 degree of theta phi for each antenna using the equations from KDB 662911 D01. The raw antenna data is located in the appendix of this report.

The correlated antenna gain was calculated using KDB 662911 D01F(2)(f)(ii) for CDD and KDB 662911 D01, F(2)(e)(ii) for TxBF.

The uncorrelated antenna gain was calculated using KDB 662911 D01F(2)(d)(ii) for SDM.

The correlated and uncorrelated gains were calculated for each point in the spatial data and the highest values reported.

(ii) If antenna gains are not equal, the user may use either of the following methods to calculate directional gain. provided that each transmit antenna s driven by only one spatial stream.

- Directional gain may be calculated by using the formulas applicable to equal gain antennas with G_{ur} set equal to the gain of the antenna having the highest gain, or,

$$Directional Gain = 10 \cdot \log \left[\frac{\sum_{j=1}^{N_{SS}} \left\{ \sum_{k=1}^{N_{ANT}} g_{j,k} \right\}^2}{N_{ANT}} \right]$$

If all transmit signals are completely uncorrelated, then

$$Directional gain = 10 \log[(10^{G_1/10} + 10^{G_2/10} + \dots + 10^{G_N/10})/N_{ANT}] \text{ dBi}$$

Maximum Correlated / Uncorrelated Gain Calculation

Correlated Gain

(Ant. Position: 2.4G Ant.1~4)

Frequency (MHz)	2400	2450	2500
Ant.1 Gain(dBi)	-2.37	-1.41	-1.38
Ant.2 Gain(dBi)	0.13	1.36	0.90
Ant.3 Gain(dBi)	-1.10	-0.36	-0.78
Ant.4 Gain(dBi)	-1.66	-0.91	-0.19
Phi (°)	130	130	130
Theta (°)	-86	-84	-86
Beamforming	4.82	5.75	5.70
Non Beamforming (CDD MODE)	4.82	5.75	5.70

(Ant. Position: 5G Ant.5~8)

Frequency (MHz)	5150	5500	5850
Ant.5 Gain(dBi)	-0.45	-4.0	2.67
Ant.6 Gain(dBi)	-1.29	-0.96	-4.8
Ant.7 Gain(dBi)	0.03	-0.52	0.86
Ant.8Gain(dBi)	-1.02	2.90	-1.77
Phi (°)	172	96	6
Theta (°)	-88	-72	-90
Beamforming	5.35	5.72	5.70
Non Beamforming (CDD MODE)	5.35	5.72	5.70

Calculation example

$$10 \times \log\{[10^{(-2.37 \text{ dBi} / 20)} + 10^{(0.13 \text{ dBi} / 20)} + 10^{(-1.1 \text{ dBi} / 20)} + 10^{(-1.66 \text{ dBi} / 20)}]^2 / 4\} = 4.82 \text{ dBi}$$

Uncorrelated Gain**(Ant. Position: 2.4G Ant.1~4)**

Frequency (MHz)	2400	2450	2500
Ant.1 Gain (dBi)	-2.32	-1.41	-1.38
Ant.2 Gain (dBi)	0.58	1.36	0.90
Ant.3 Gain (dBi)	-1.42	-0.36	-0.78
Ant.4 Gain (dBi)	-1.98	-0.91	-0.19
Phi (°)	132	130	130
Theta (°)	-84	-84	-86
Uncorrelated gain	-1.13	-0.20	-0.28

(Ant. Position: 5G Ant.5~8)

Frequency (MHz)	5150	5500	5850
Ant.5 Gain (dBi)	-0.45	-4.00	2.67
Ant.6 Gain (dBi)	-1.29	-0.96	-4.80
Ant.7 Gain (dBi)	0.03	-0.53	0.86
Ant.8 Gain (dBi)	-1.02	2.90	-1.77
Phi (°)	172	96	6
Theta (°)	-88	-72	-90
Uncorrelated gain	-0.65	0.04	0.07

(Ant. Position: 6G Ant.A~D)

Frequency (MHz)	5925	6500	7125
Ant.A Gain (dBi)	-4.42	2.17	-2.77
Ant.B Gain (dBi)	0.12	-1.14	0.55
Ant.C Gain (dBi)	-0.01	1.38	-10.21
Ant.D Gain (dBi)	1.69	-5.67	3.66
Phi (°)	4	144	170
Theta (°)	88	88	-104
Uncorrelated gain	-0.16	0.07	0.09

Calculation example

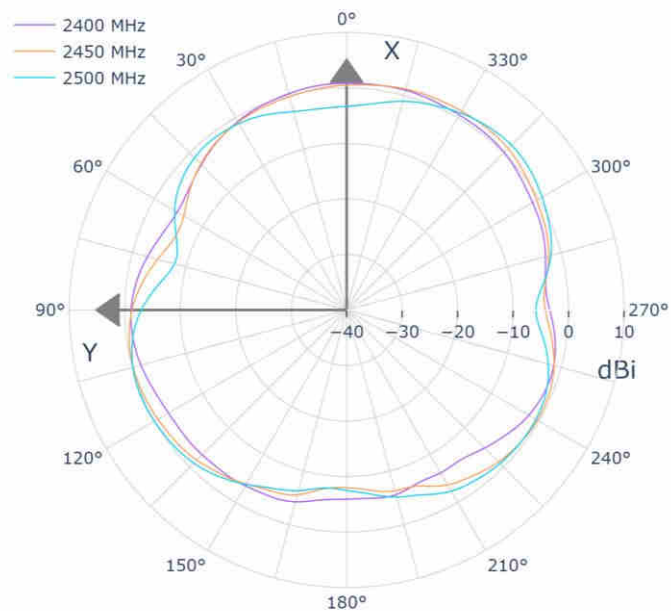
$$=10 \times \log_{10}(((10^{(-2.32 \text{ dBi} / 10)} + 10^{(0.58 \text{ dBi} / 10)} + 10^{(-1.42 \text{ dBi} / 10)} + 10^{(-1.98 \text{ dBi} / 10)})) / 4)$$

$$=-1.13 \text{ dBi}$$

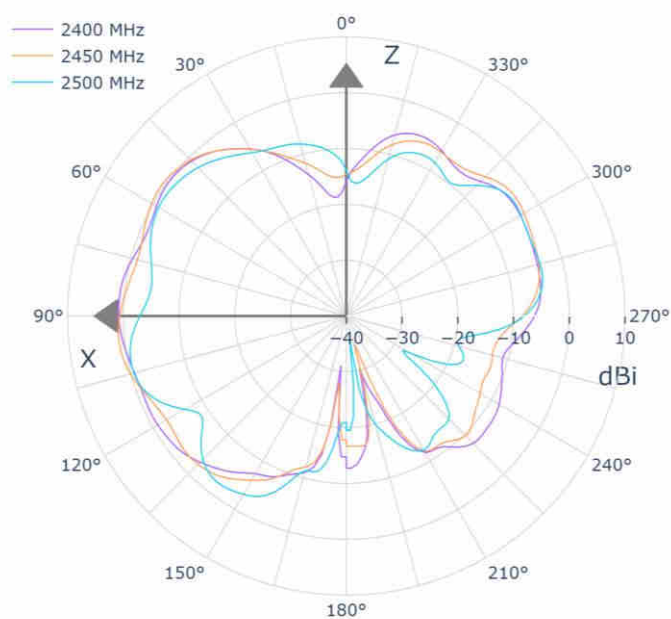
9. Radiation Pattern

Ant. Position: 2.4G Ant.1~4

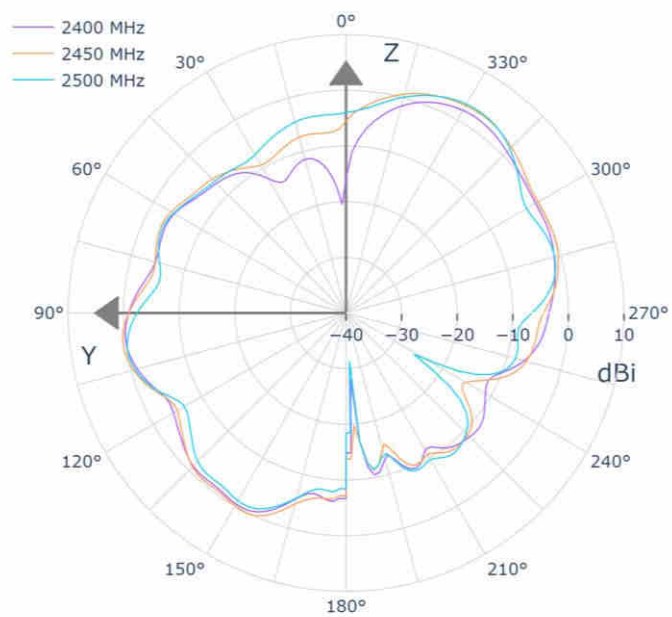
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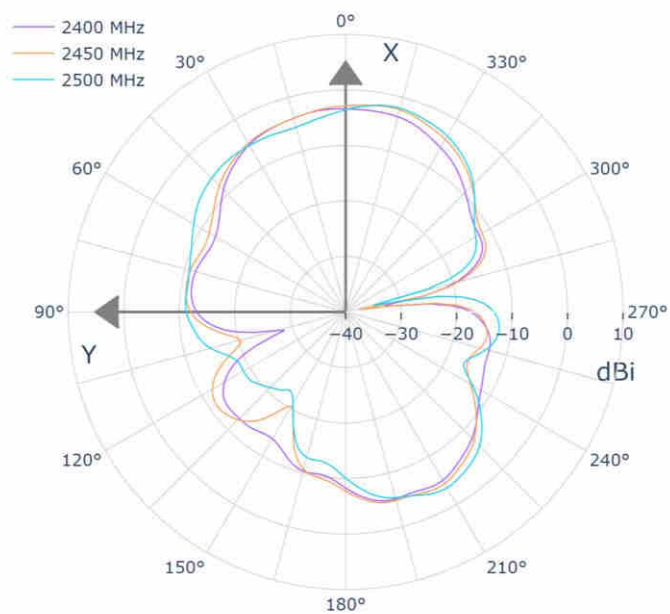
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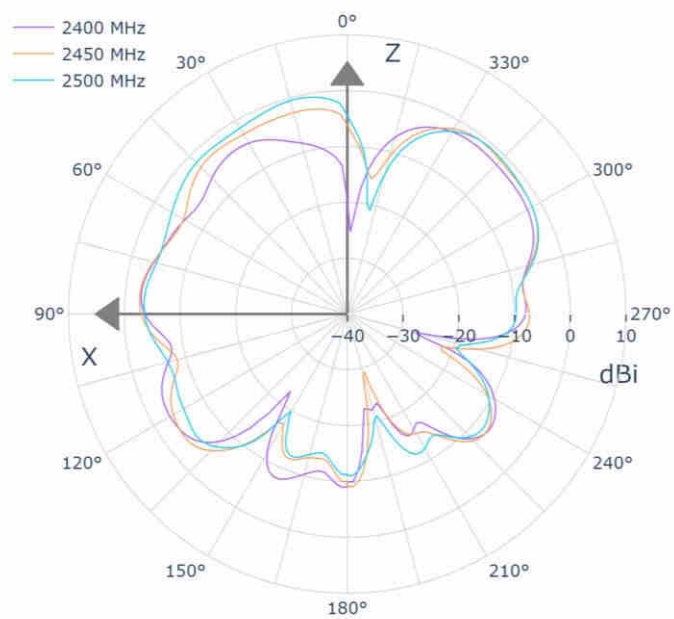
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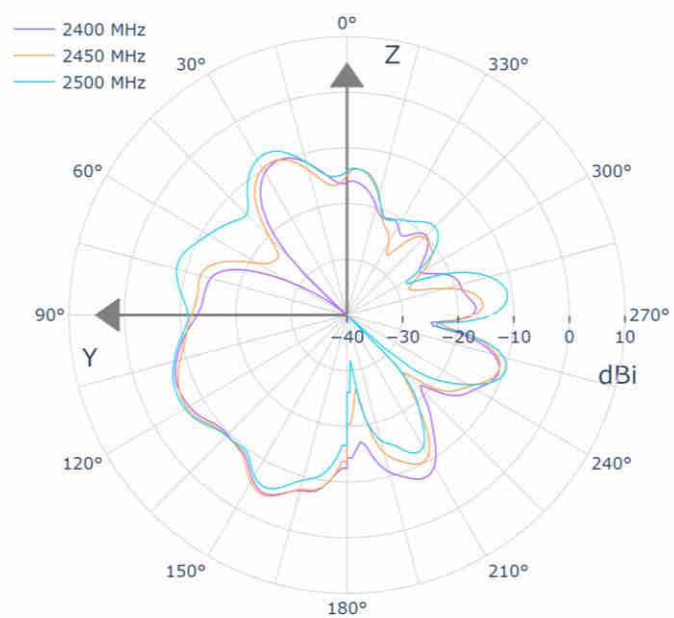
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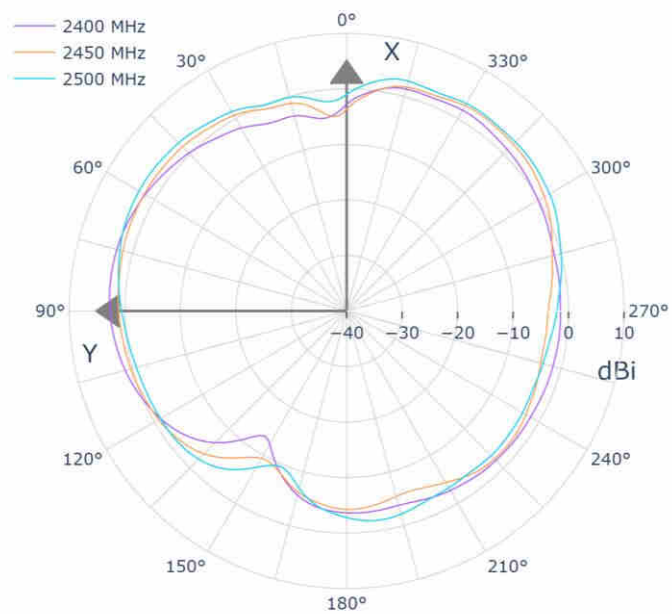
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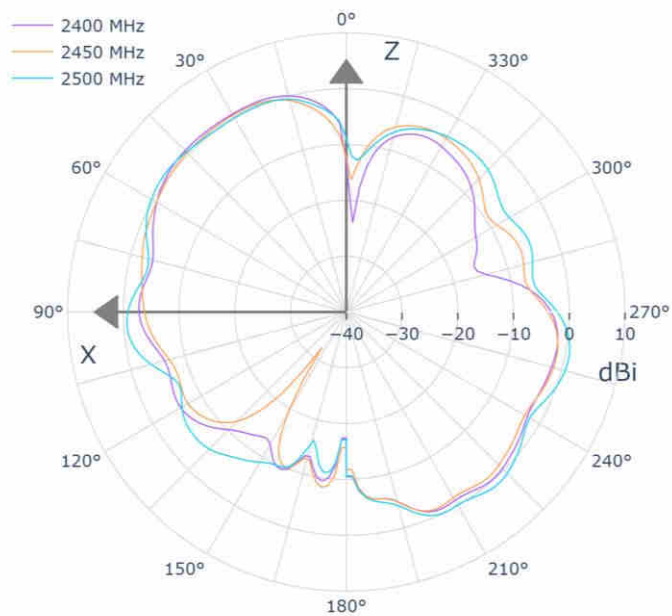
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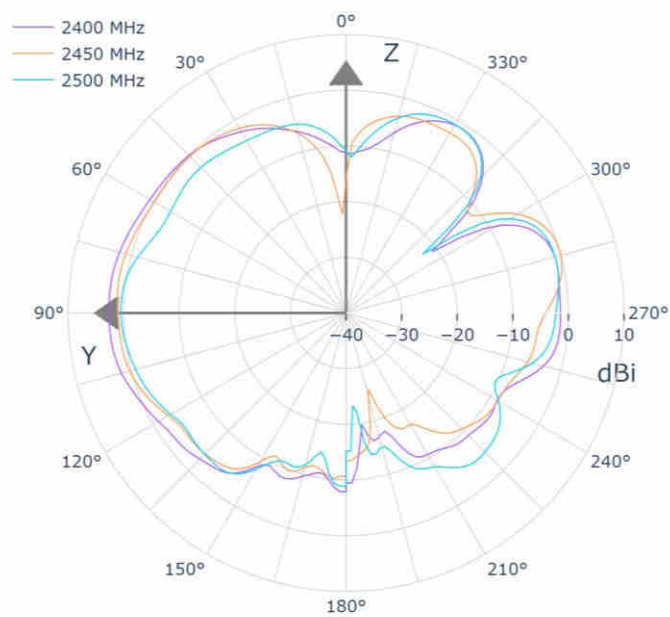
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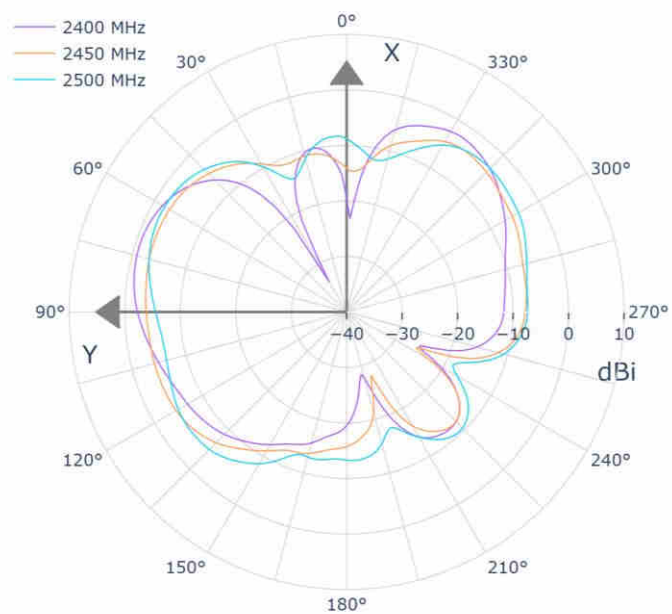
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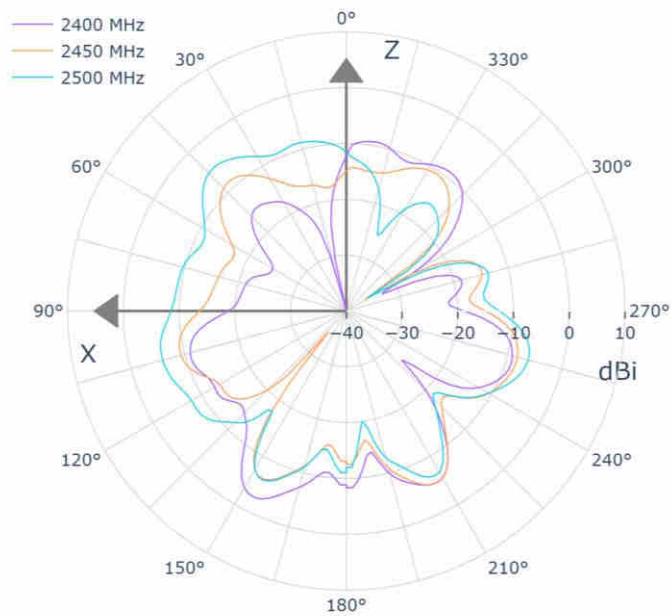
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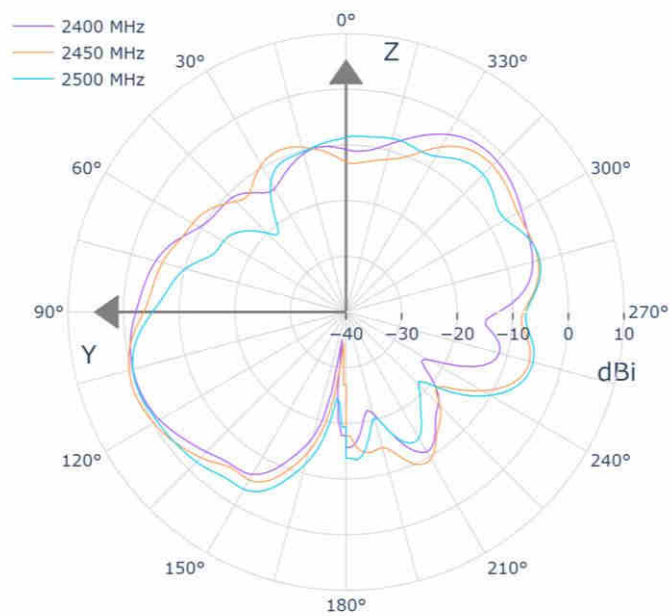
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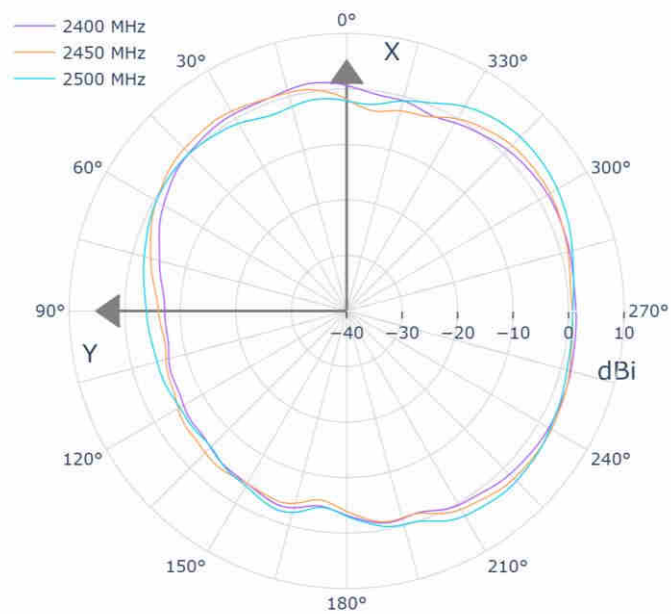
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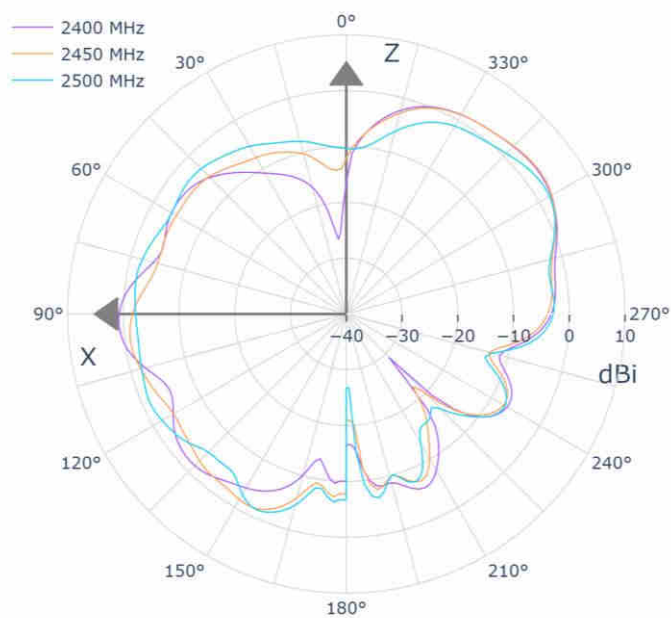
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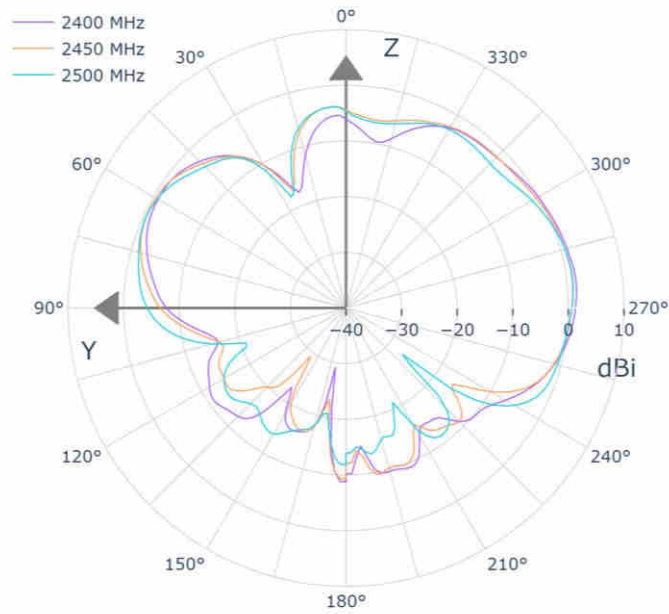
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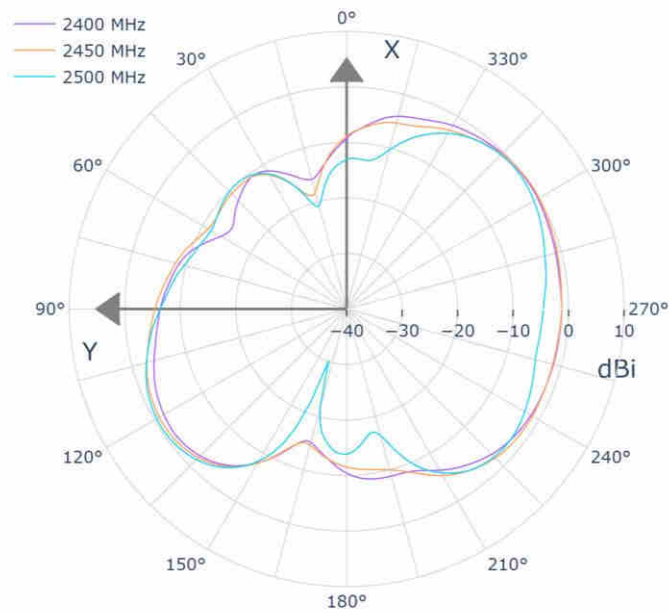
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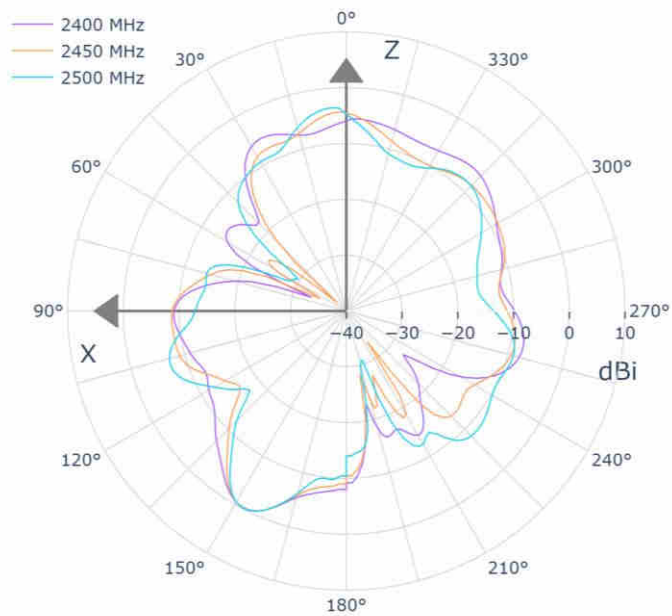
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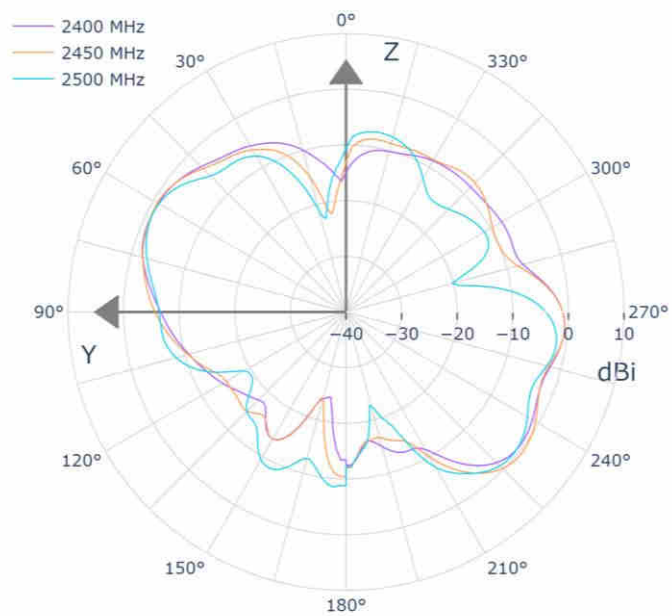
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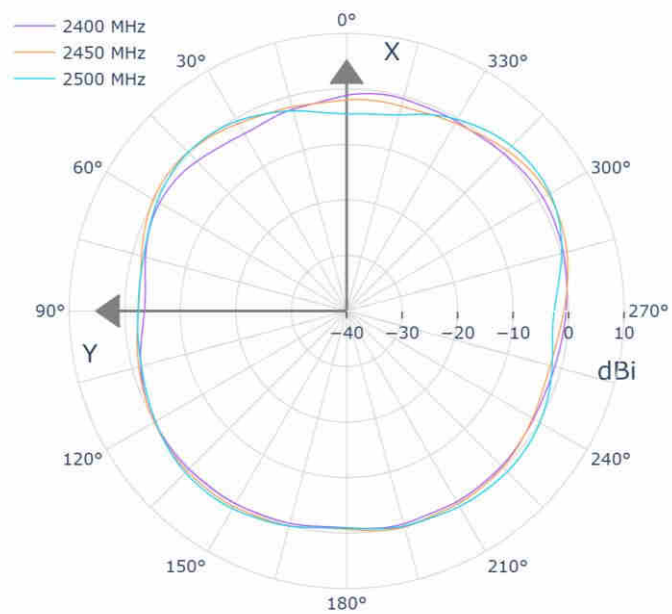
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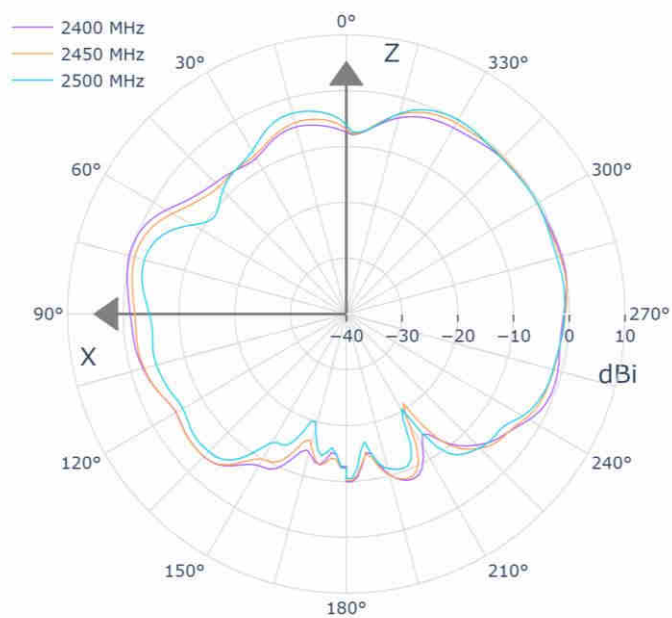
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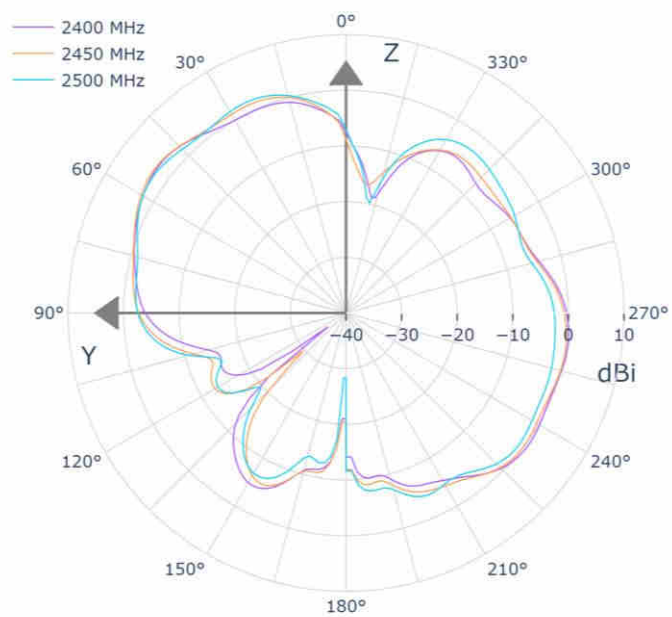
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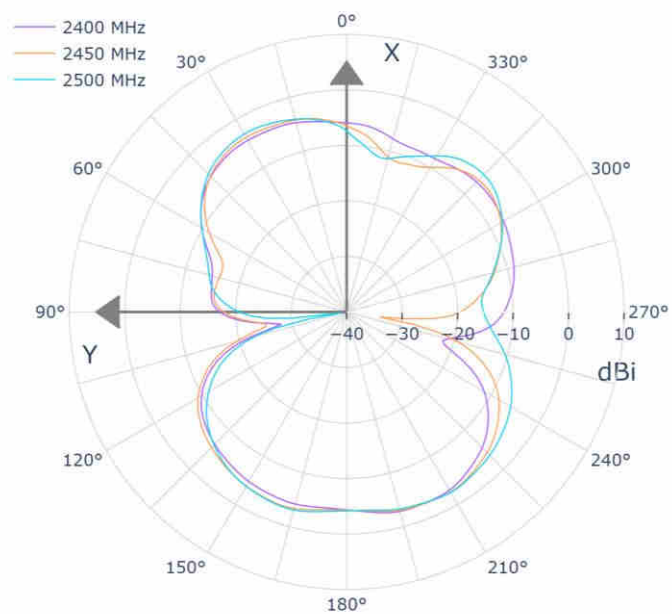
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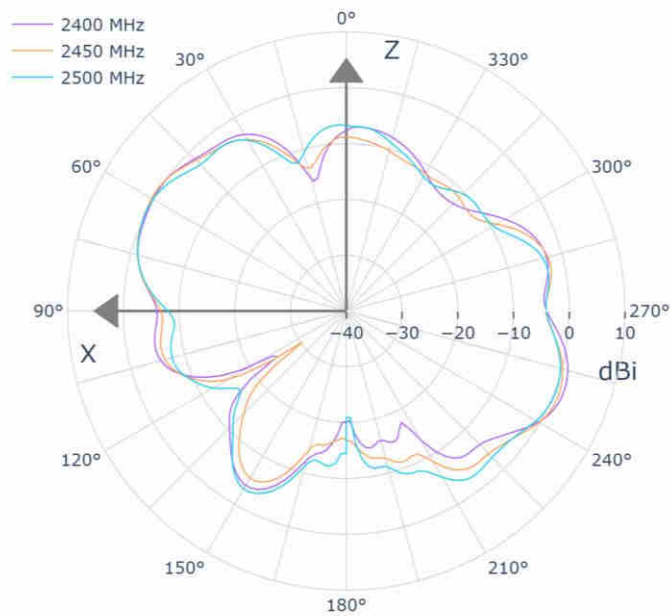
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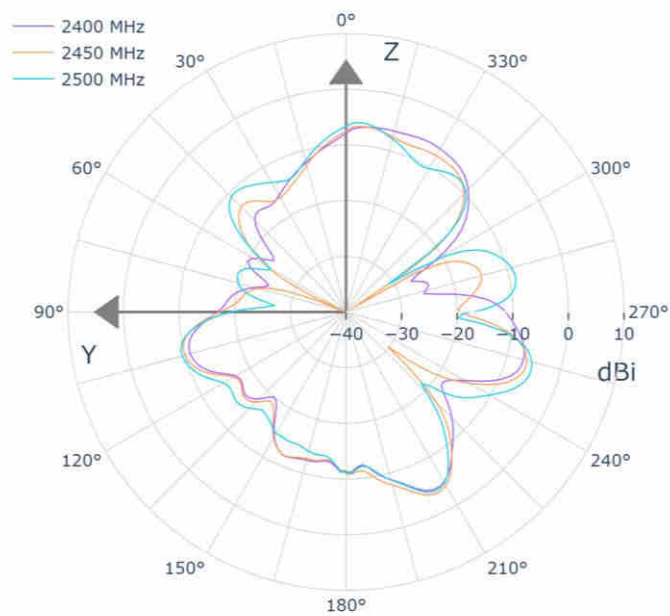
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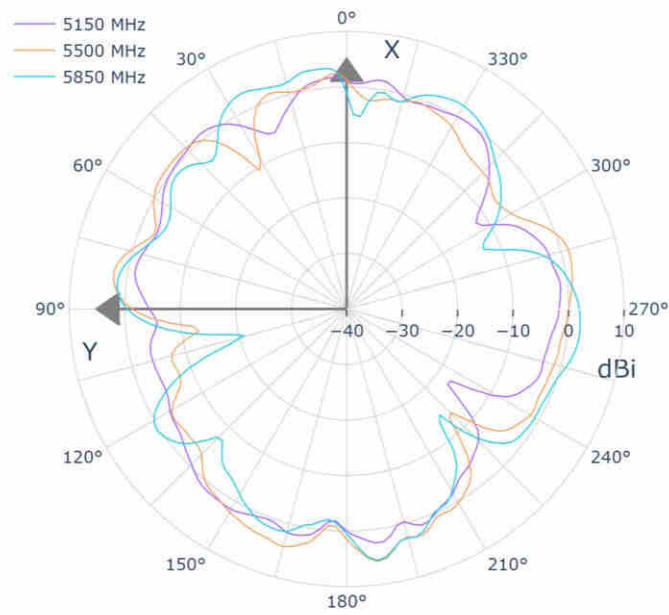


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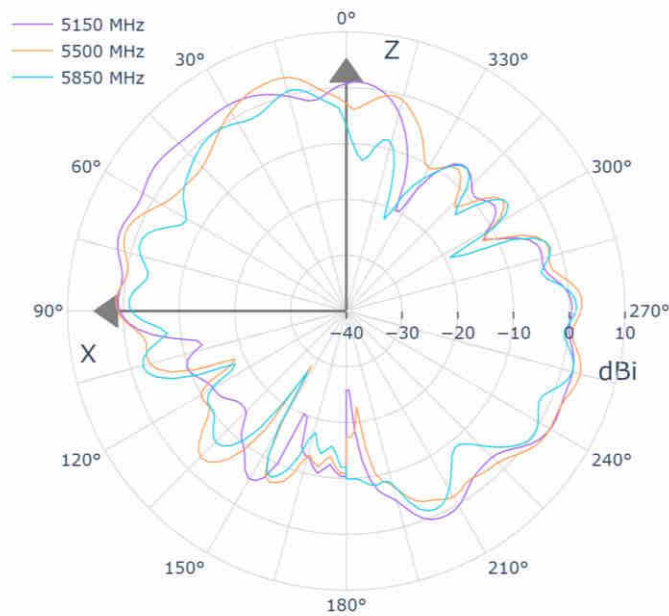


Ant. Position: 5G Ant.5~8

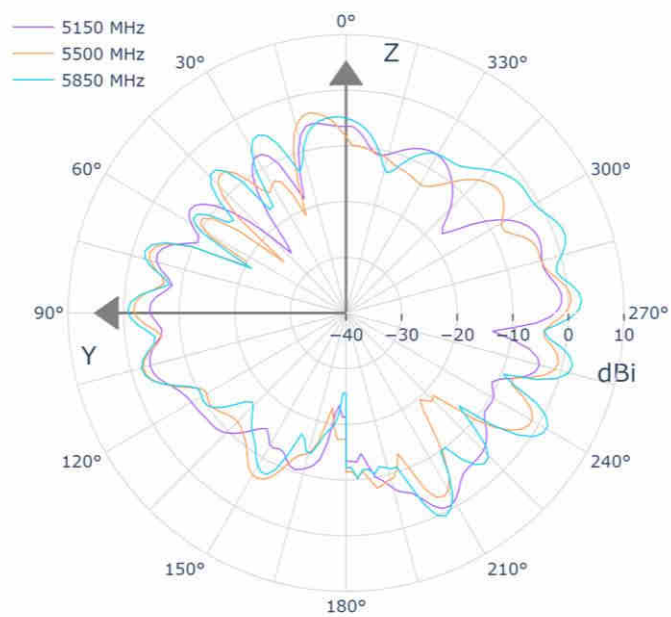
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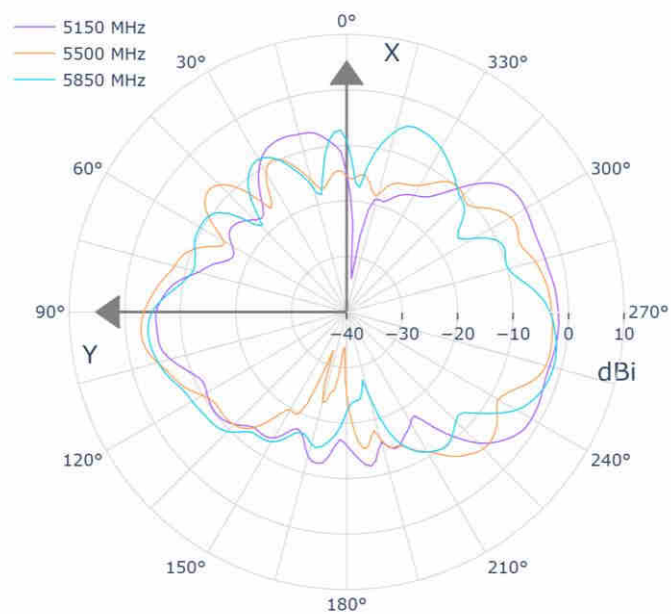
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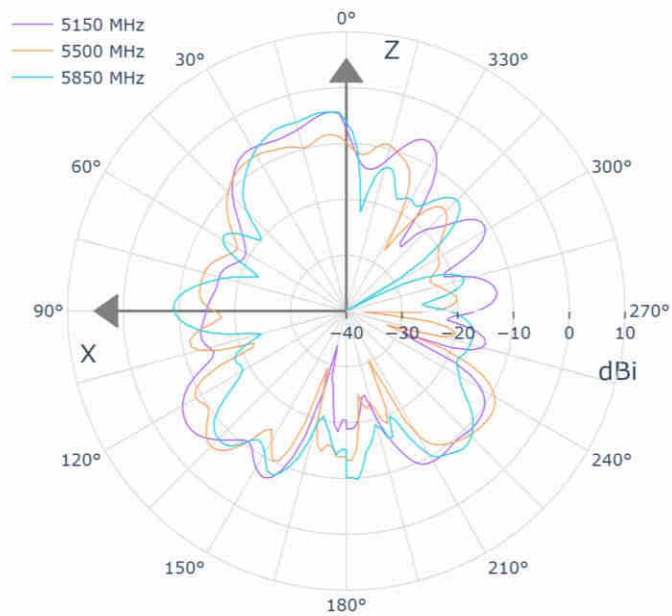
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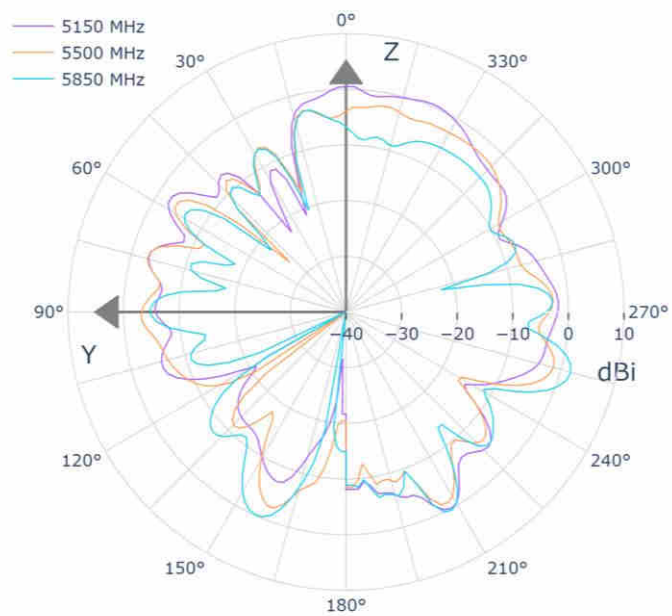
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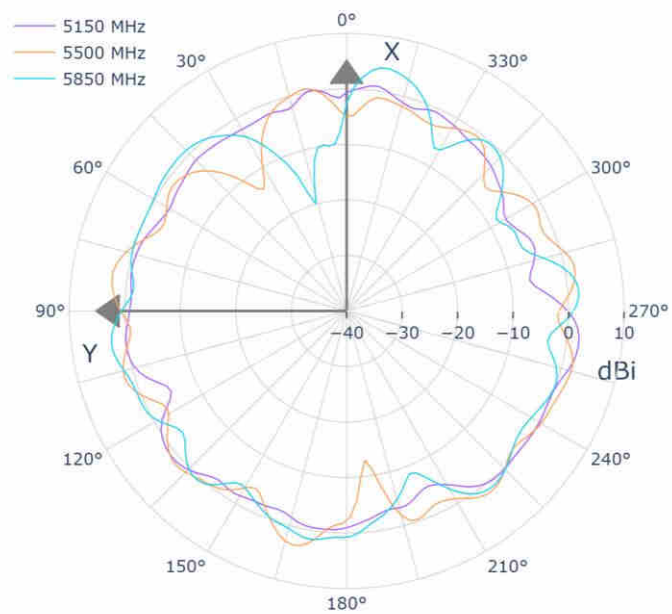
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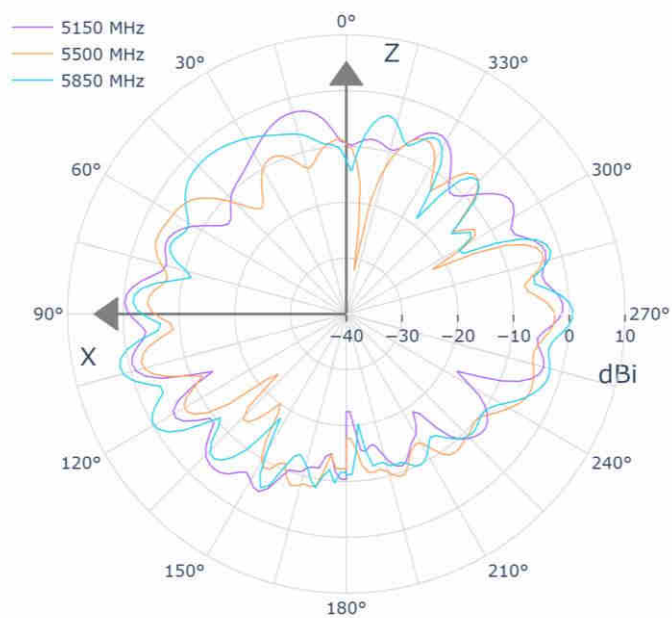
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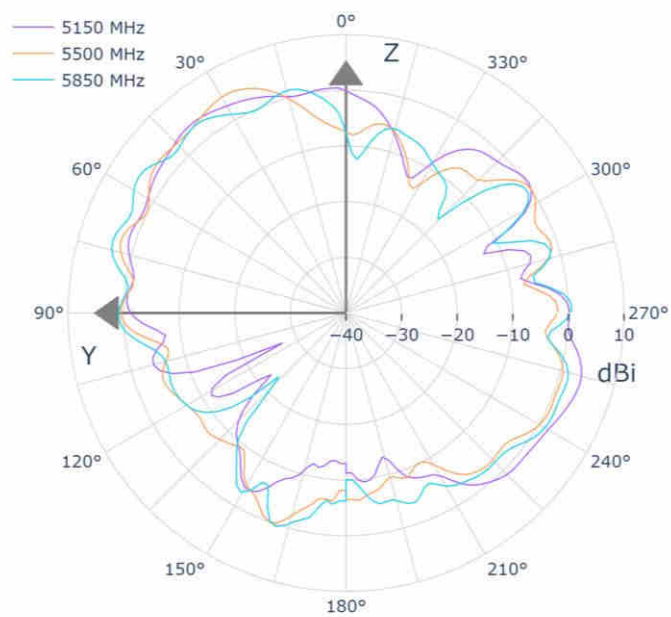
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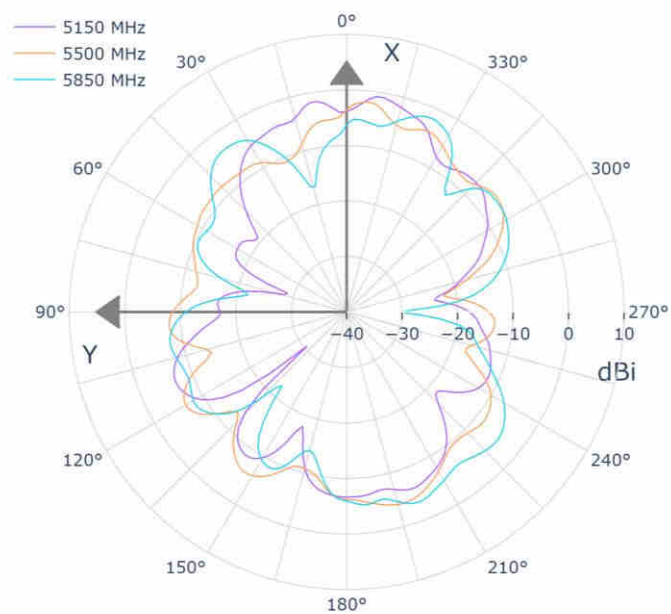
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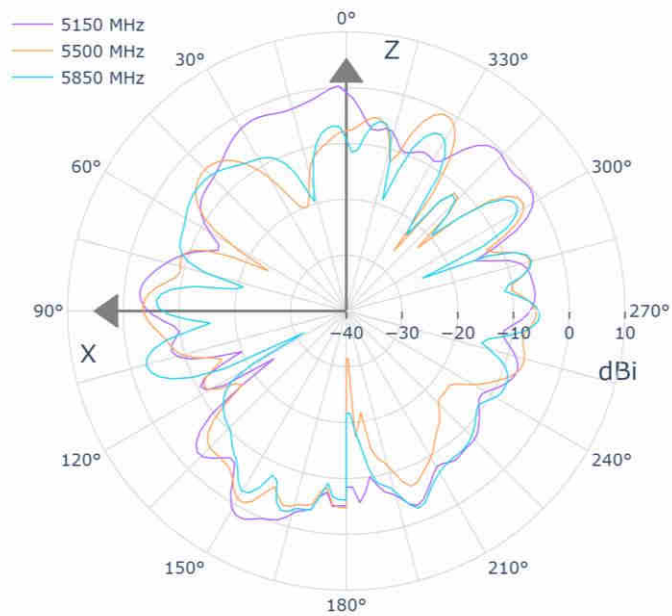
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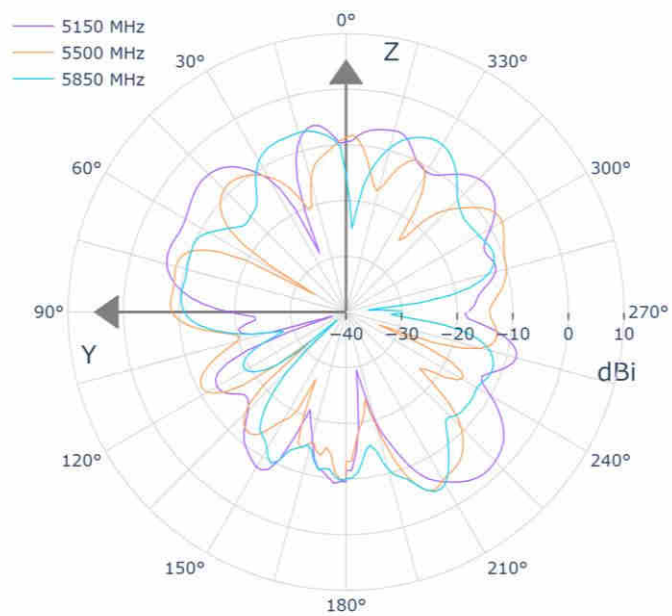
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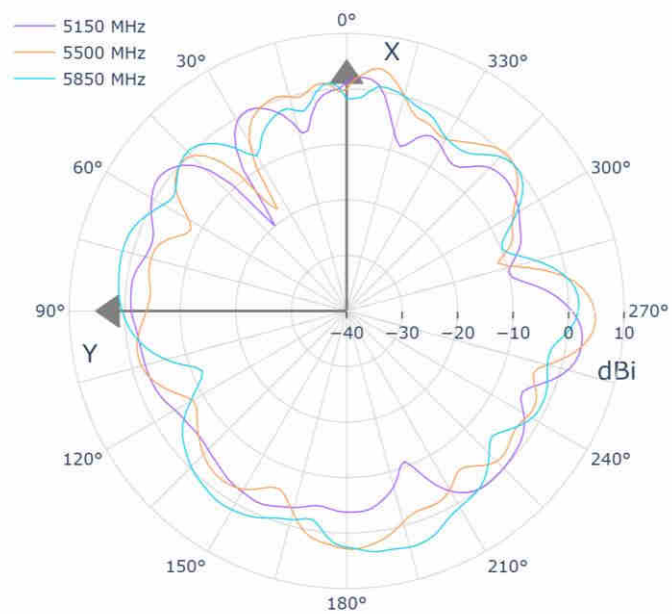
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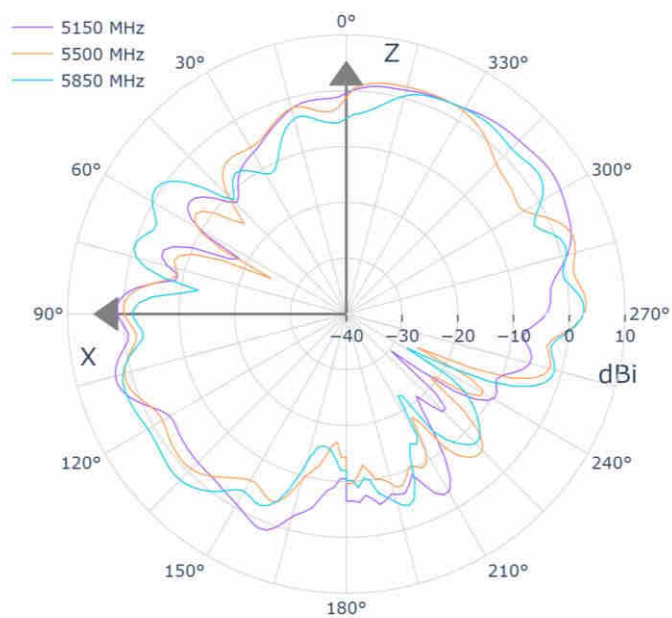
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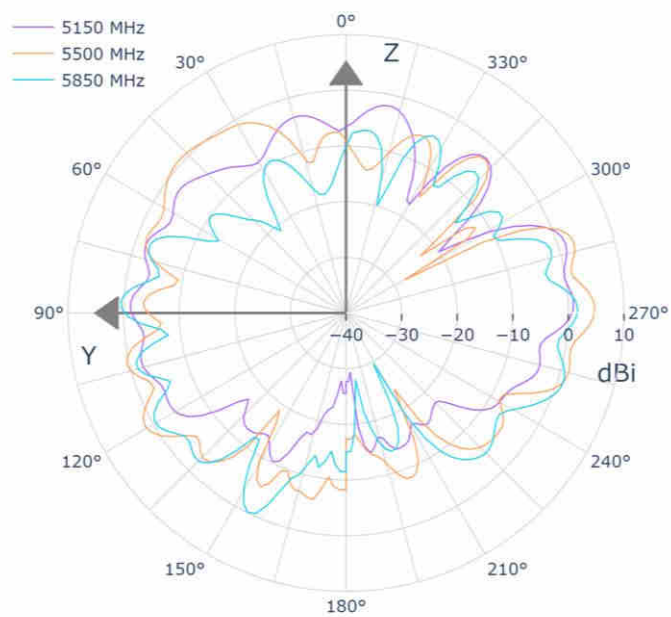
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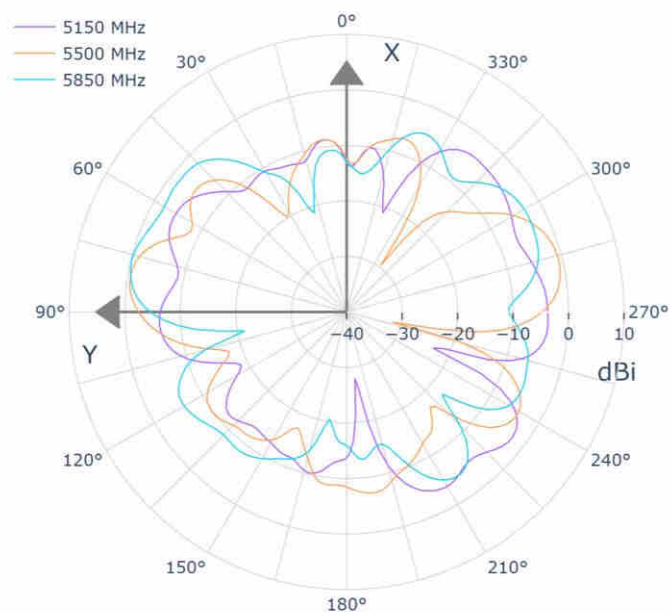
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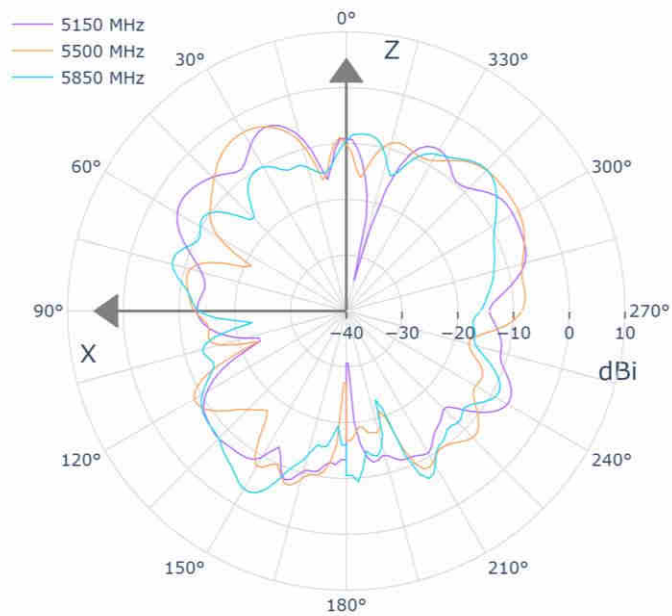
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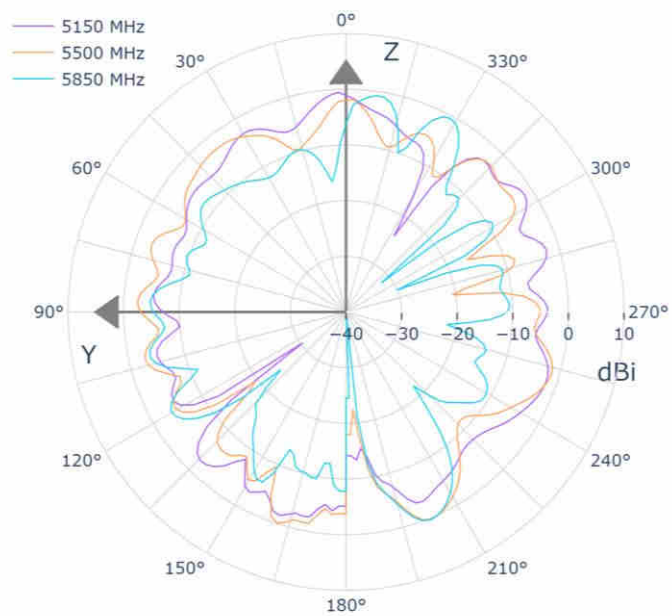
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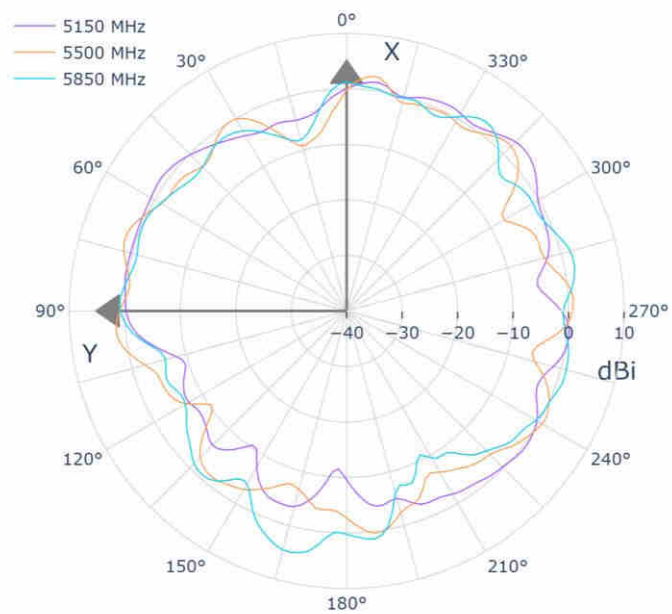
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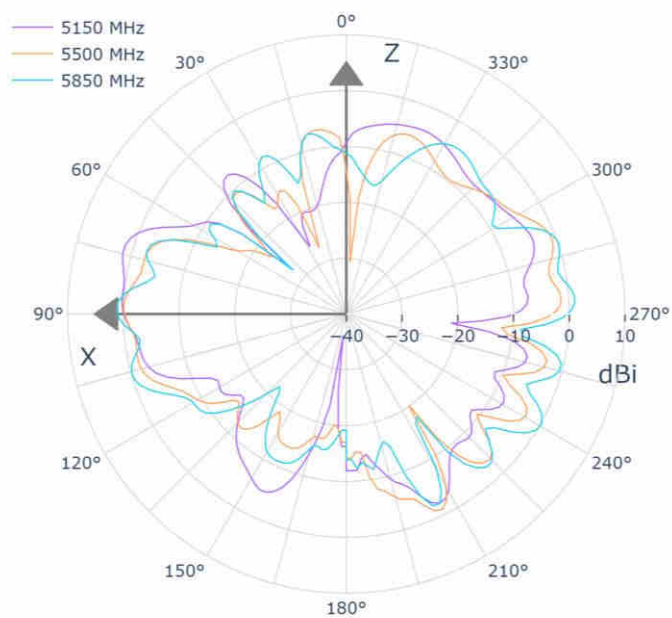
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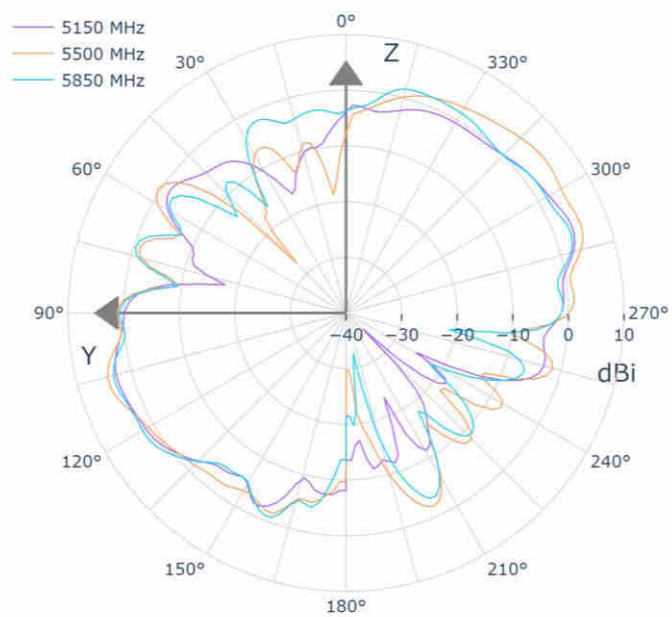
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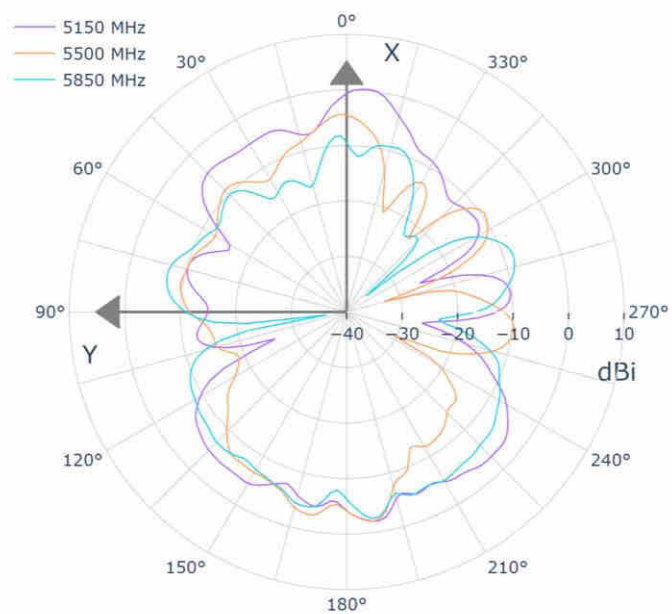
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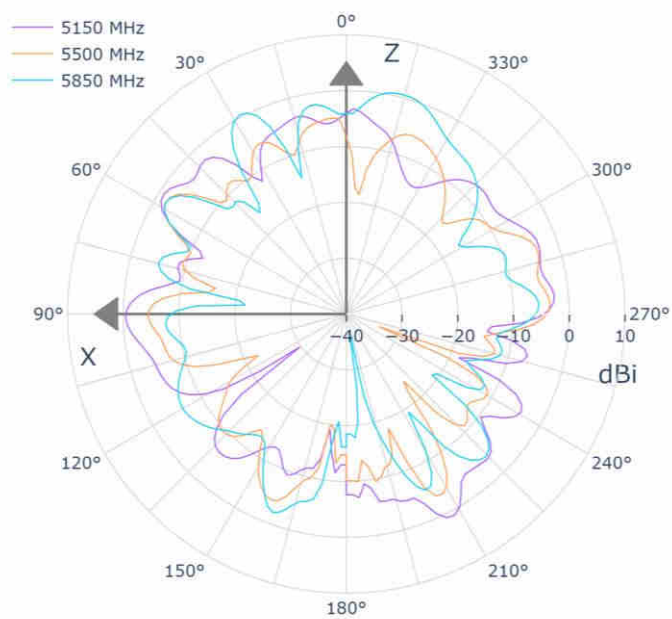
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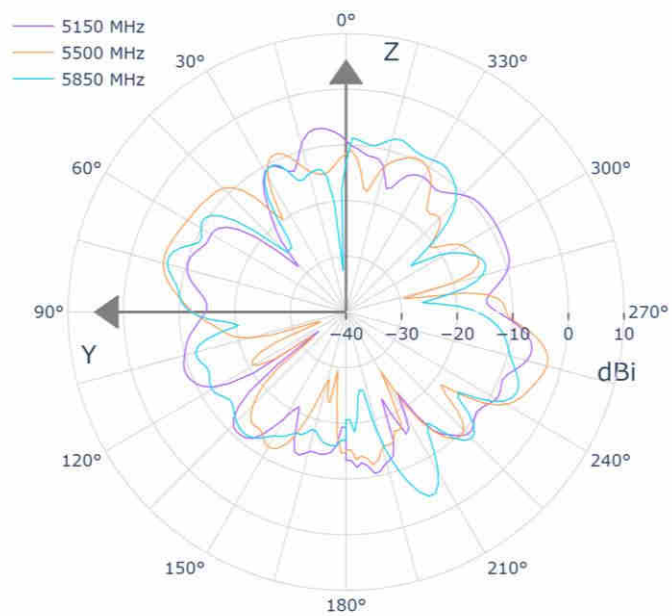
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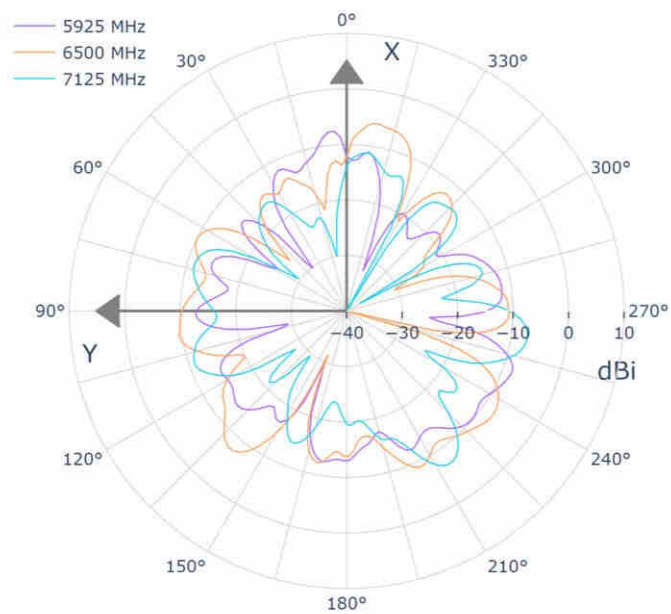
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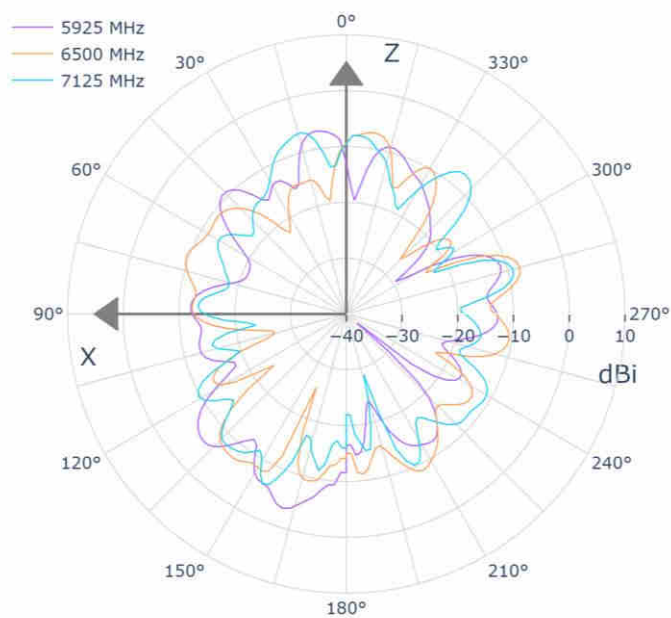
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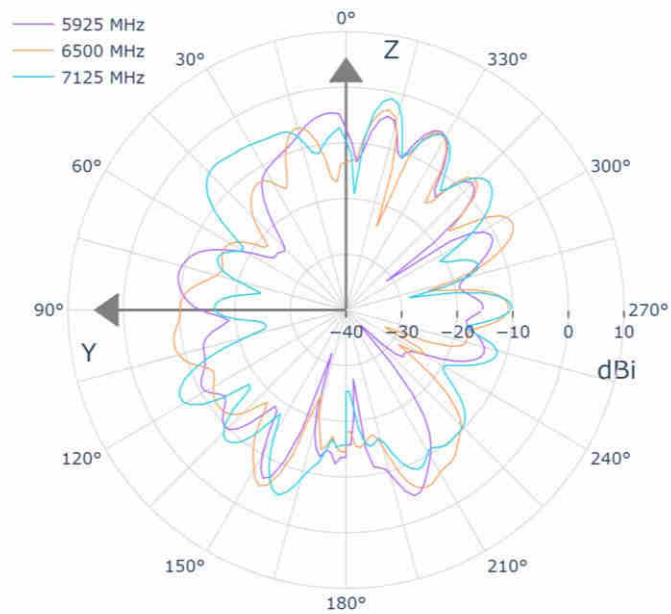
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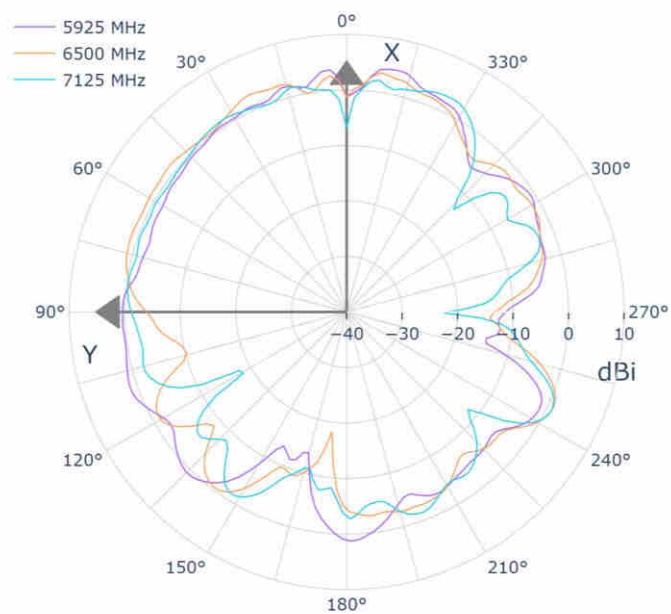
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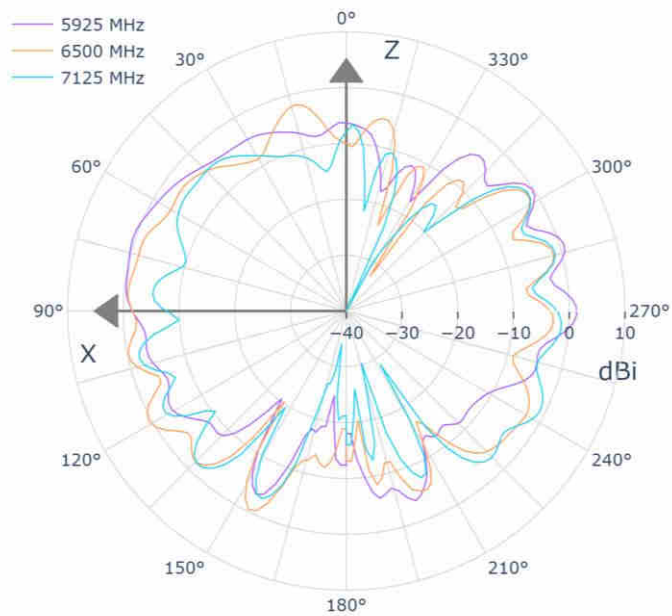
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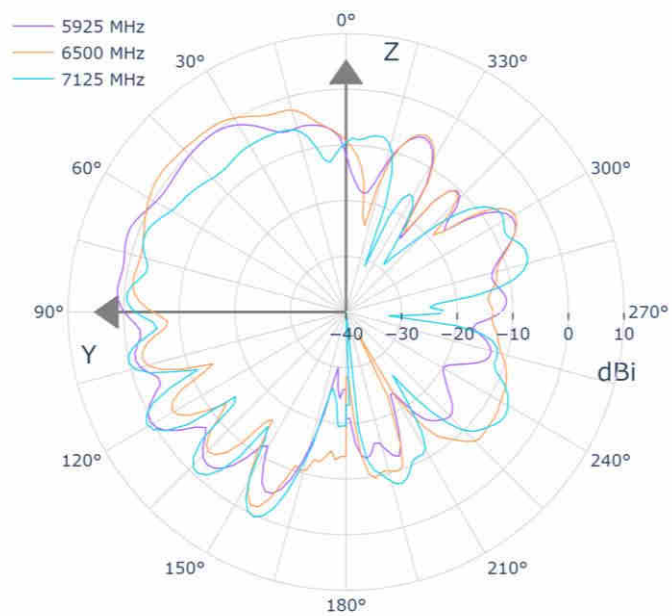
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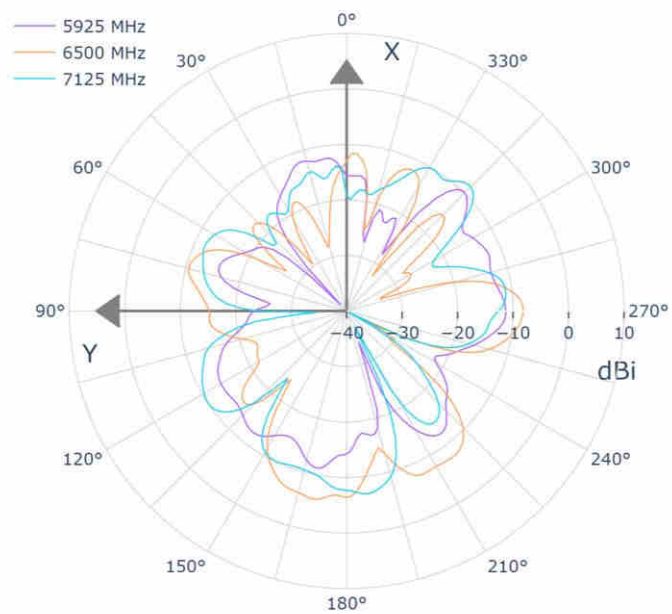
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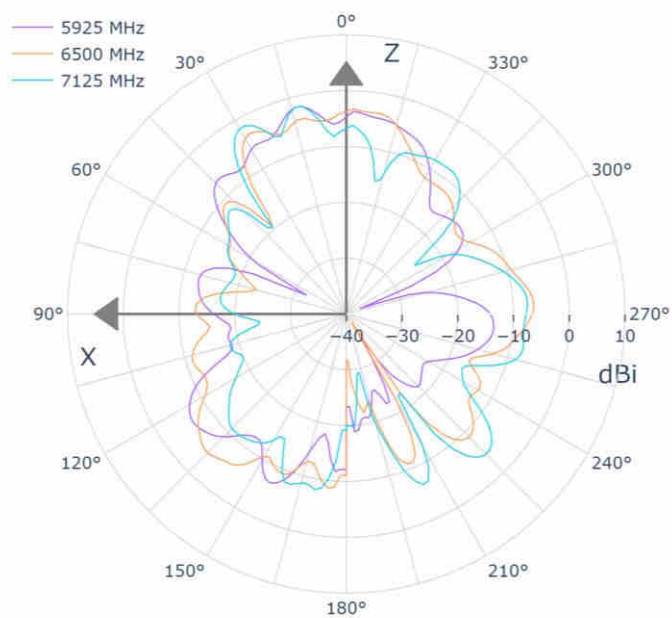
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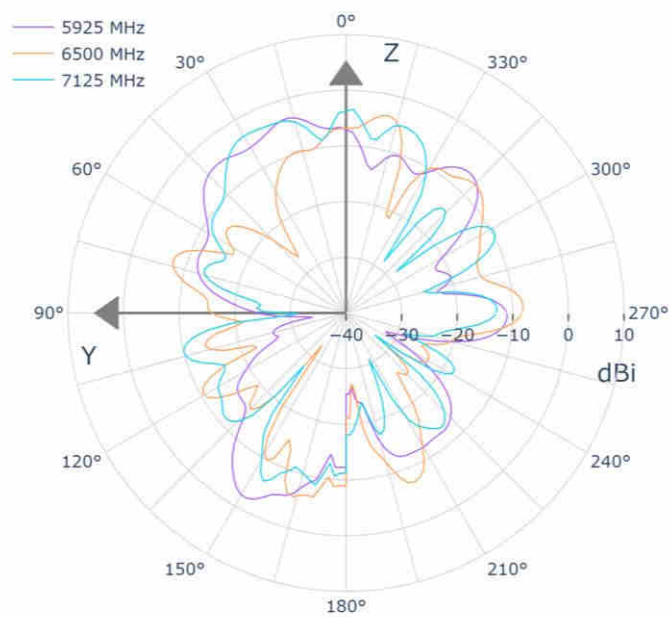
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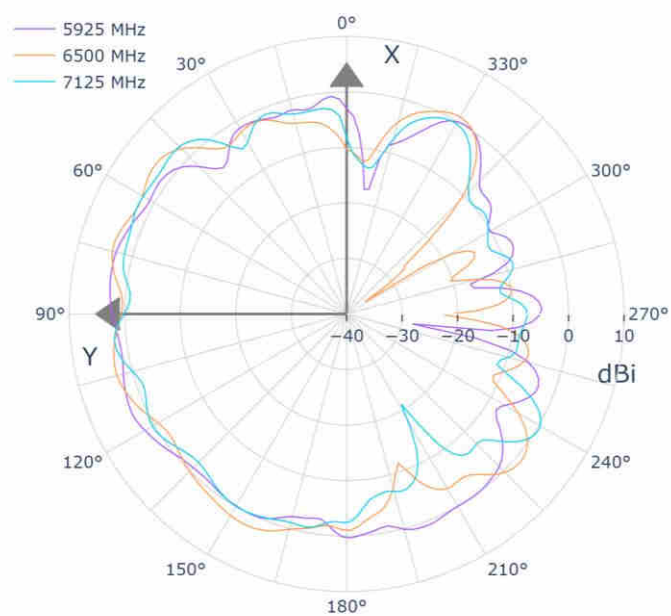
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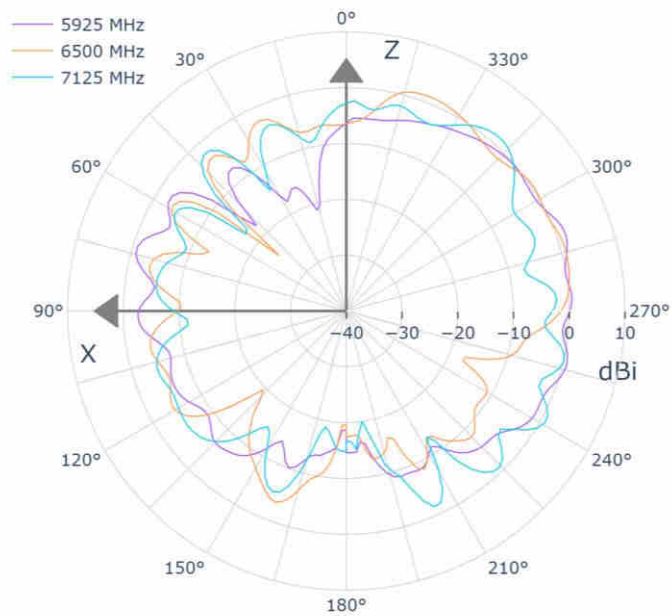
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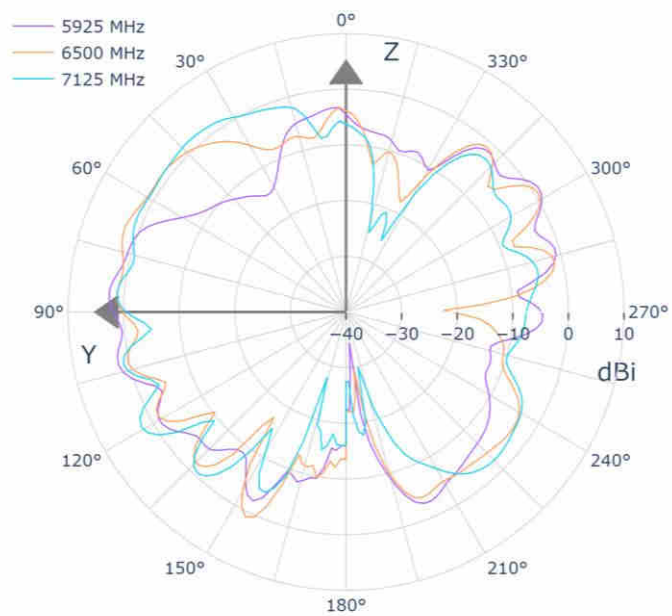
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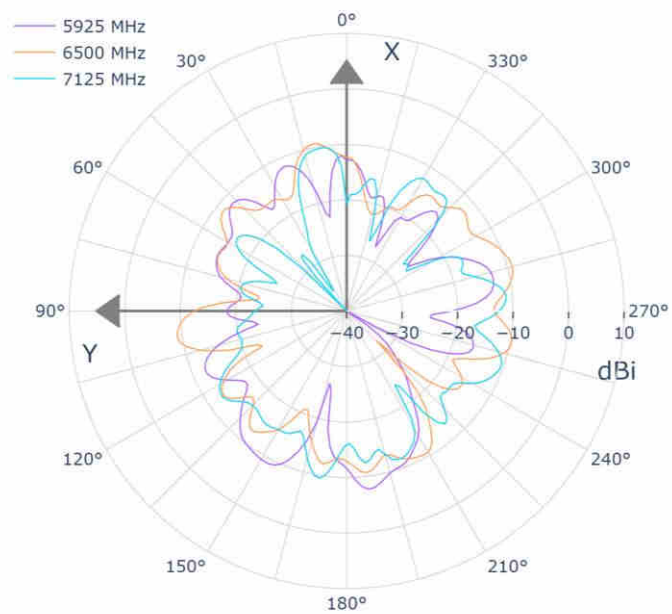
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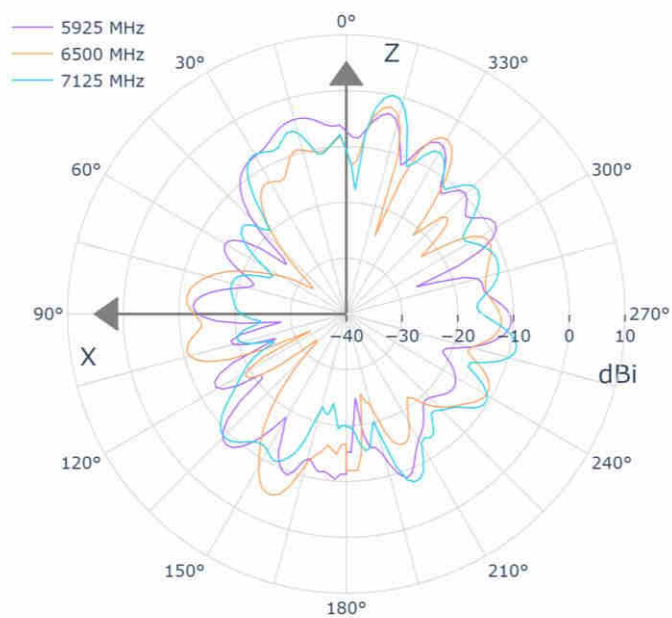
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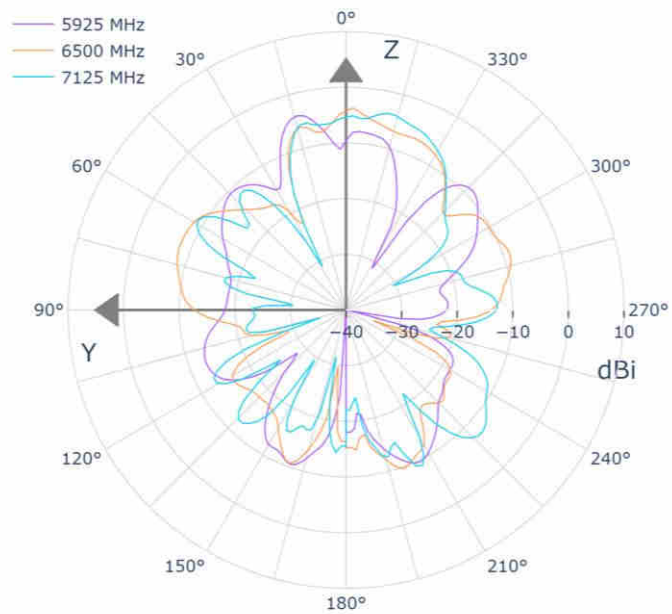
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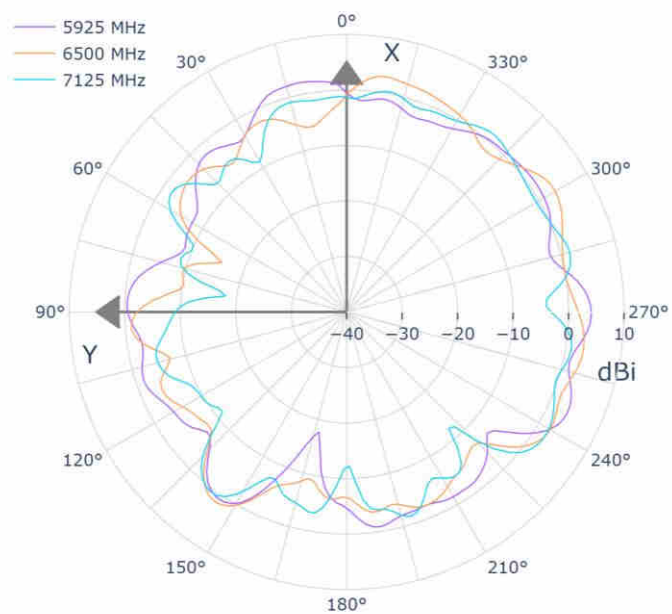
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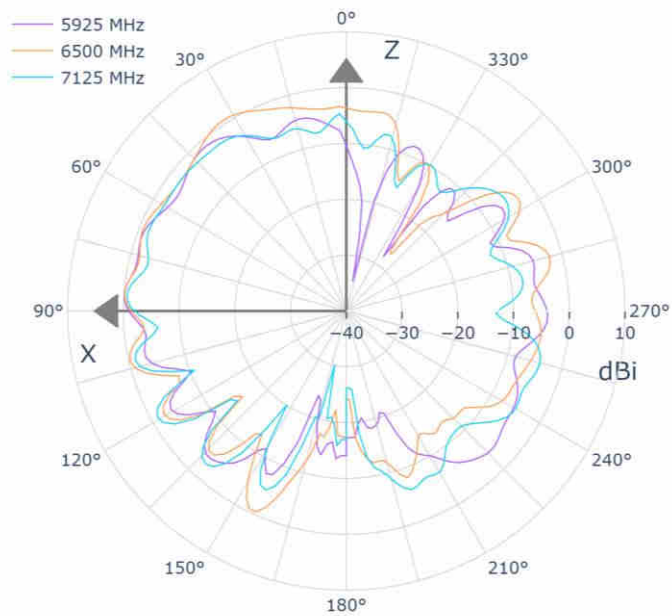
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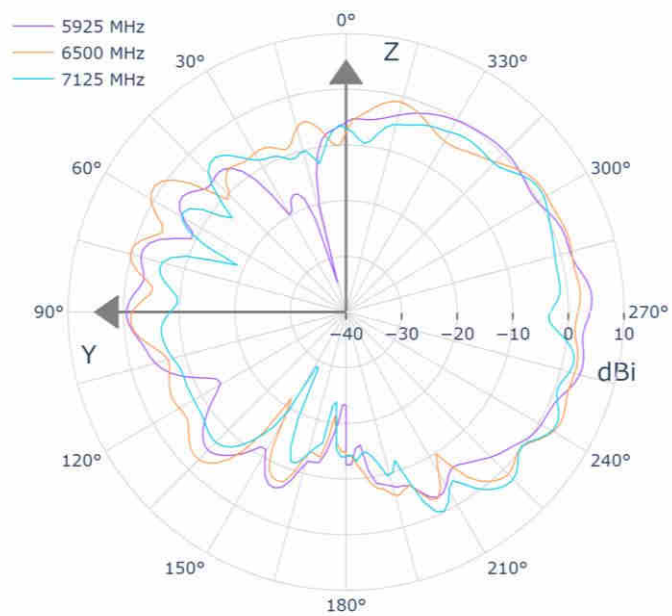
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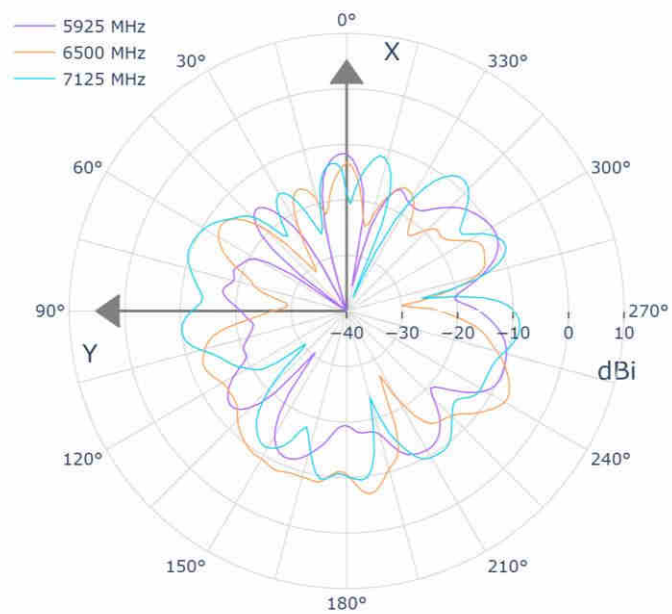
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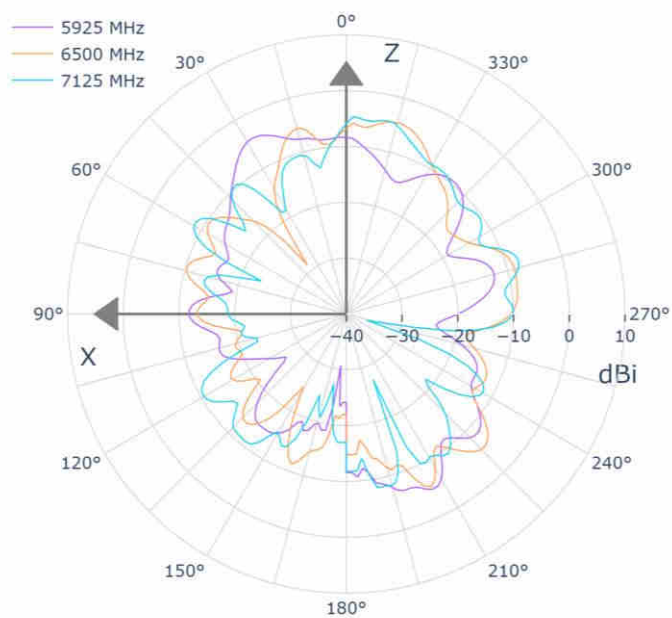
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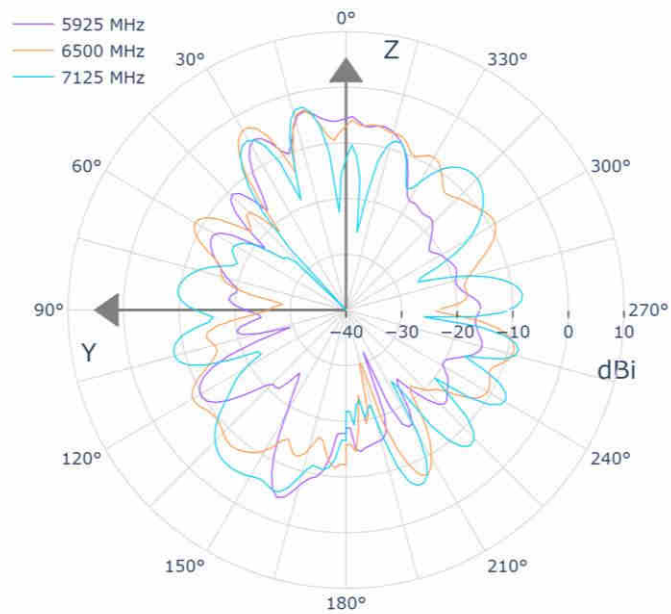
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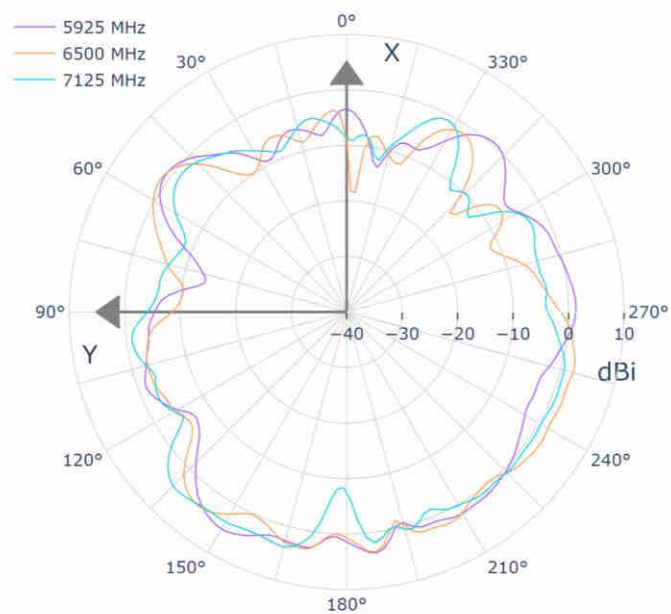
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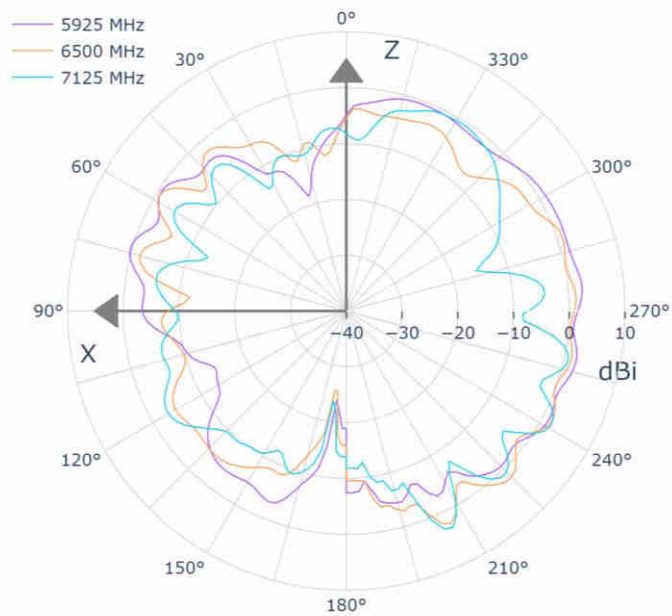
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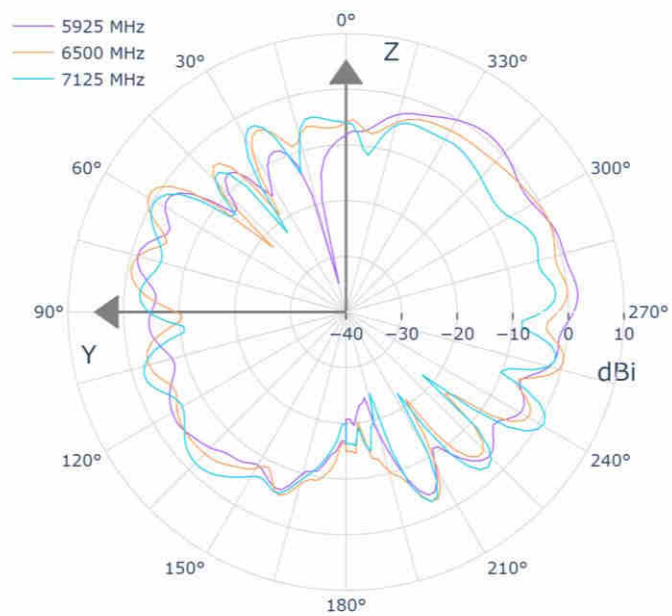
XY_Pol._Theta_Ant.D@6G



XZ_Pol._Theta_Ant.D@5G



YZ_Pol._Phi_Ant.D@6G



Ant. Position: 2.4G Ant.1_GAIN THETA

0000	0001	0002	0003	0004	0005	0006	0007	0008	0009	0010	0011	0012	0013	0014	0015	0016	0017	0018	0019	0020	0021	0022	0023	0024	0025	0026	0027	0028	0029	0030	0031	0032	0033	0034	0035	0036	0037	0038	0039	0040	0041	0042	0043	0044	0045	0046	0047	0048	0049	0050	0051	0052	0053	0054	0055	0056	0057	0058	0059	0060	0061	0062	0063	0064	0065	0066	0067	0068	0069	0070	0071	0072	0073	0074	0075	0076	0077	0078	0079	0080	0081	0082	0083	0084	0085	0086	0087	0088	0089	0090	0091	0092	0093	0094	0095	0096	0097	0098	0099
0100	0101	0102	0103	0104	0105	0106	0107	0108	0109	0110	0111	0112	0113	0114	0115	0116	0117	0118	0119	0120	0121	0122	0123	0124	0125	0126	0127	0128	0129	0130	0131	0132	0133	0134	0135	0136	0137	0138	0139	0140	0141	0142	0143	0144	0145	0146	0147	0148	0149	0150	0151	0152	0153	0154	0155	0156	0157	0158	0159	0160	0161	0162	0163	0164	0165	0166	0167	0168	0169	0170	0171	0172	0173	0174	0175	0176	0177	0178	0179	0180	0181	0182	0183	0184	0185	0186	0187	0188	0189	0190	0191	0192	0193	0194	0195	0196	0197	0198	0199
0200	0201	0202	0203	0204	0205	0206	0207	0208	0209	0210	0211	0212	0213	0214	0215	0216	0217	0218	0219	0220	0221	0222	0223	0224	0225	0226	0227	0228	0229	0230	0231	0232	0233	0234	0235	0236	0237	0238	0239	0240	0241	0242	0243	0244	0245	0246	0247	0248	0249	0250	0251	0252	0253	0254	0255	0256	0257	0258	0259	0260	0261	0262	0263	0264	0265	0266	0267	0268	0269	0270	0271	0272	0273	0274	0275	0276	0277	0278	0279	0280	0281	0282	0283	0284	0285	0286	0287	0288	0289	0290	0291	0292	0293	0294	0295	0296	0297	0298	0299
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Ant. Position: 2.4G Ant.3_GAIN PHI

[illegible]

Ant. Position: 2.4G Ant.3_GAIN THETA

[illegible]

Ant. Position: 2.4G Ant.4_GAIN THETA

[illegible]

Ant. Position: 5G Ant.5_GAIN THETA

[illegible]

Ant. Position: 6G Ant.A_GAIN THETA

[illegible]

Ant. Position: 6G Ant.B_GAIN THETA

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Ant. Position: 6G Ant.D_GAIN PHI

75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
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153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178
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205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230
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387	388	389	390	391	392	393	394	395	396	397	398	399	400	401	402	403	404	405	406	407	408	409	410	411	412
413	414	415	416	417	418	419	420	421	422	423	424	425	426	427	428	429	430	431	432	433	434	435	436	437	438
439	440	441	442	443	444	445	446	447	448	449	450	451	452	453	454	455	456	457	458	459	460	461	462	463	464
465	466	467	468	469	470	471	472	473	474	475	476	477	478	479	480	481	482	483	484	485	486	487	488	489	490
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517	518	519	520	521	522	523	524	525	526	527	528	529	530	531	532	533	534	535	536	537	538	539	540	541	542
543	544	545	546	547	548	549	550	551	552	553	554	555	556	557	558	559	560	561	562	563	564	565	566	567	568
569	570	571	572	573	574	575	576	577	578	579	580	581	582	583	584	585	586	587	588	589	590	591	592	593	594
595	596	597	598	599	600	601	602	603	604	605	606	607	608	609	610	611	612	613	614	615	616	617	618	619	620
621	622	623	624	625	626	627	628	629	630	631	632	633	634	635	636	637	638	639	640	641	642	643	644	645	646
647	648	649	650	651	652	653	654	655	656	657	658	659	660	661	662	663	664	665	666	667	668	669	670	671	672
673	674	675	676	677	678	679	680	681	682	683	684	685	686	687	688	689	690	691	692	693	694	695	696	697	698
699	700	701	702	703	704	705	706	707	708	709	710	711	712	713	714	715	716	717	718	719	720	721	722	723	724
725	726	727	728	729	730	731	732	733	734	735	736	737	738	739	740	741	742	743	744	745	746	747	748	749	750
751	752	753	754	755	756	757	758	759	760	761	762	763	764	765	766	767	768	769	770	771	772	773	774	775	776
777	778	779	780	781	782	783	784	785	786	787	788	789	790	791	792	793	794	795	796	797	798	799	800	801	802
803	804	805	806	807	808	809	810	811	812	813	814	815	816	817	818	819	820	821	822	823	824	825	826	827	828
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881	882	883	884	885	886	887	888	889	890	891	892	893	894	895	896	897	898	899	900	901	902	903	904	905	906
907	908	909	910	911	912	913	914	915	916	917	918	919	920	921	922	923	924	925	926	927	928	929	930	931	932
933	934	935	936	937	938	939	940	941	942	943	944	945	946	947	948	949	950	951	952	953	954	955	956	957	958
959	960	961	962	963	964	965	966	967	968	969	970	971	972	973	974	975	976	977	978	979	980	981	982	983	984
985	986	987	988	989	990	991	992	993	994	995	996	997	998	999	1000	1001	1002	1003	1004	1005	1006	1007	1008	1009	1010
1011	1012	1013	1014	1015	1016	1017	1018	1019	1020	1021	1022	1023	1024	1025	1026	1027	1028	1029	1030	1031	1032	1033	1034	1035	1036
1037	1038	1039	1040	1041	1042	1043	1044	1045	1046	1047	1048	1049	1050	1051	1052	1053	1054	1055	1056	1057	1058	1059	1060	1061	1062
1063	1064	1065	1066	1067	1068	1069	1070	1071	1072	1073	1074	1075	1076	1077	1078	1079	1080	1081	1082	1083	1084	1085	1086	1087	1088
1089	1090	1091	1092	1093	1094	1095	1096	1097	1098	1099	1100	1101	1102	1103	1104	1105	1106	1107	1108	1109	1110	1111	1112	1113	1114
1115	1116	1117	1118	1119	1120	1121	1122	1123	1124	1125	1126	1127	1128	1129	1130	1131	1132	1133	1134	1135	1136	1137	1138	1139	1140
1141	1142	1143	1144	1145	1146	1147	1148	1149	1150	1151	1152	1153	1154	1155	1156	1157	1158	1159	1160	1161	1162	1163	1164	1165	1166
1167	1168	1169	1170	1171	1172	1173	1174	1175	1176	1177	1178	1179	1180	1181	1182	1183	1184	1185	1186	1187	1188	1189	1190	1191	1192
1193	1194	1195	1196	1197	1198	1199	1200	1201	1202	1203	1204	1205	1206	1207	1208	1209	1210	1211	1212	1213	1214	1215	1216	1217	1218
1219	1220	1221	1222	1223	1224	1225	1226	1227	1228	1229	1230	1231	1232	1233	1234	1235	1236	1237	1238	1239	1240	1241	1242	1243	1244
1245	1246	1247	1248	1249	1250	1251	1252	1253	1254	1255	1256	1257	1258	1259	1260	1261	1262	1263	1264	1265	1266	1267	1268	1269	1270
1271	1272	1273	1274	1275	1276	1277	1278	1279	1280	1281	1282	1283	1284	1285	1286	1287	1288	1289	1290	1291	1292	1293	1294	1295	1296
1297	1298	1299	1300	1301	1302	1303	1304	1305	1306	1307	1308	1309	1310	1311	1312	1313	1314	1315	1316	1317	1318	1319	1320	1321	1322
1323	1324	1325	1326	1327	1328	1329	1330	1331	1332	1333	1334	1335	1336	1337	1338	1339	1340	1341	1342	1343	1344	1345	1346	1347	1348
1349	1350	1351	1352	1353	1354	1355	1356	1357	1358	1359	1360	1361	1362	1363	1364	1365	1366	1367	1368	1369	1370	1371	1372	1373	1374
1375	1376	1377	1378	1379	1380	1381	1382	1383	1384	1385	1386	1387	1388	1389	1390	1391	1392	1393	1394	1395	1396	1397	1398	1399	1400
1401	1402	1403	1404	1405	1406	1407	1408	1409	1410	1411	1412	1413	1414	1415	1416	1417	1418	1419	1420	1421	1422	1423	1424	1425	1426
1427	1428	1429	1430	1431	1432	1433	1434	1435	1436	1437	1438	1439	1440	1441	1442	1443	1444	1445	1446	1447	1448	1449	1450	1451	1452
1453	1454	1455	1456	1457	1458	1459	1460	1461	1462	1463	1464	1465	1466	1467	1468	1469	1470	1471	1472	1473	1474	1475	1476	1477	1478
1479	1480	1481	1482	1483	1484	1485	1486	1487	1488	1489	1490	1491	1492	1493	1494	1495	1496	1497	1498	1499	1500	1501	1502	1503	1504
1505	1506	1507	1508	1509	1510	1511																			

Ant. Position: 6G Ant.D_GAIN THETA

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