

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, BachengTown, 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

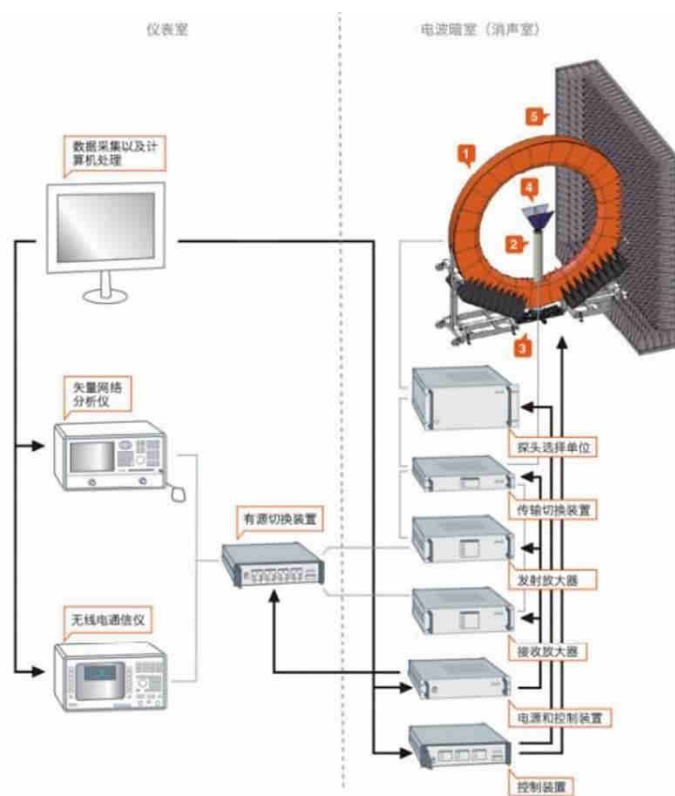
3. Test Frequency

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

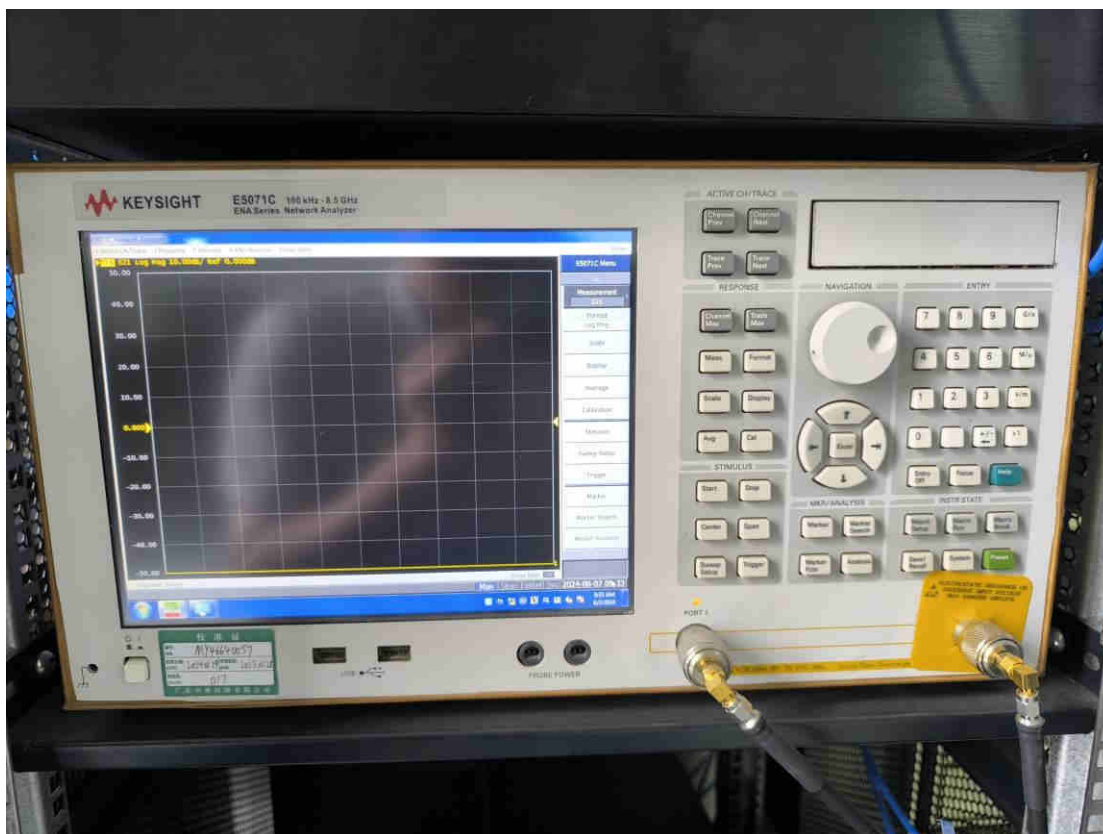
4. Antenna Information

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.8 Gain(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

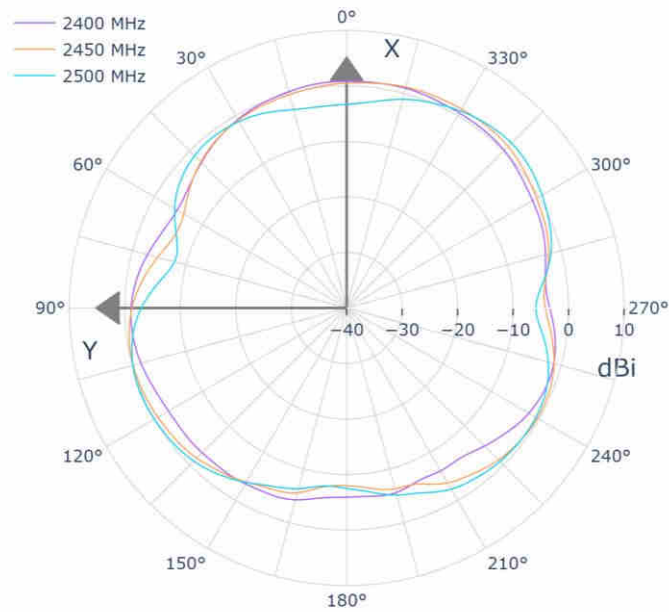
Calculation example

$$=10 \times \log_{10} \left(\frac{10^{-2.32} + 10^{0.58} + 10^{-1.42} + 10^{-1.98}}{4} \right) = -1.13 \text{ dBi}$$

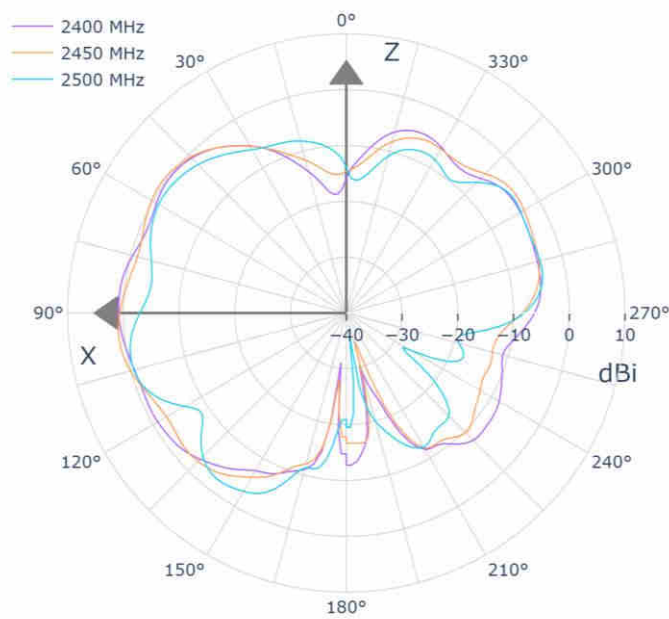
9. Radiation Pattern

Ant. Position: 2.4G Ant.1~4

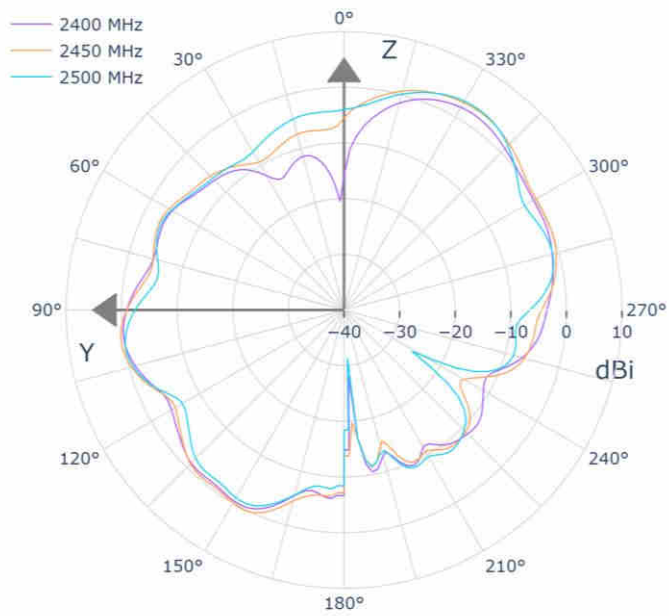
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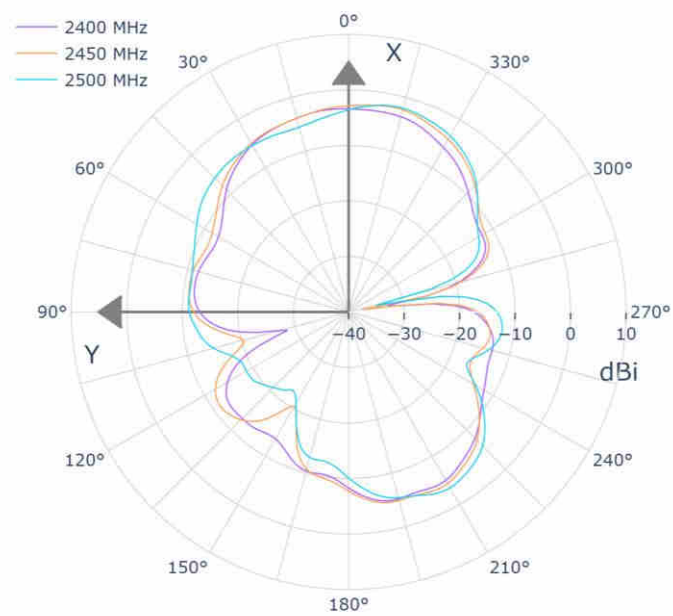
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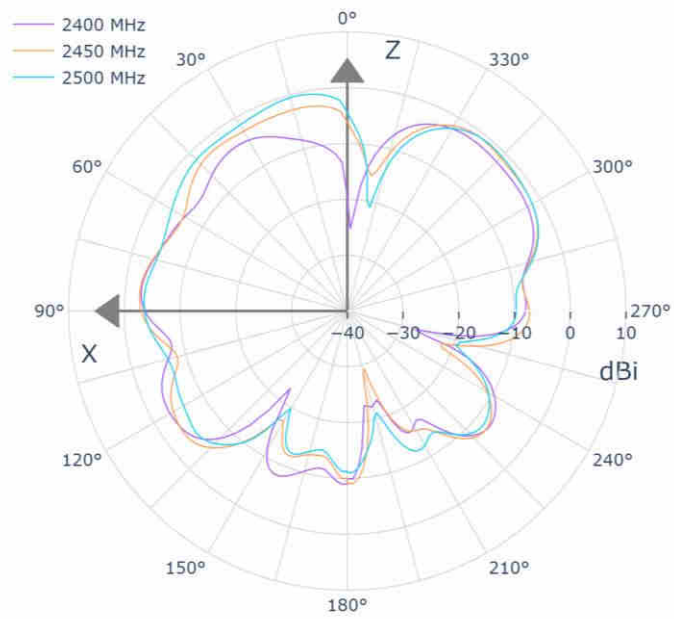
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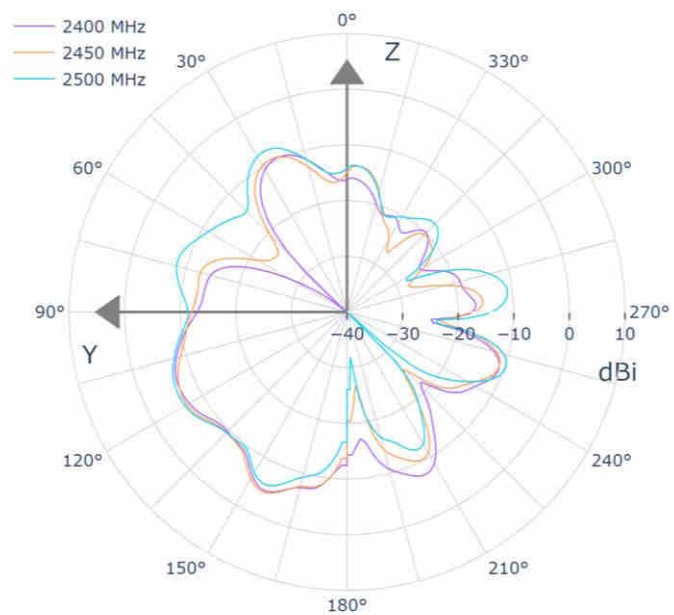
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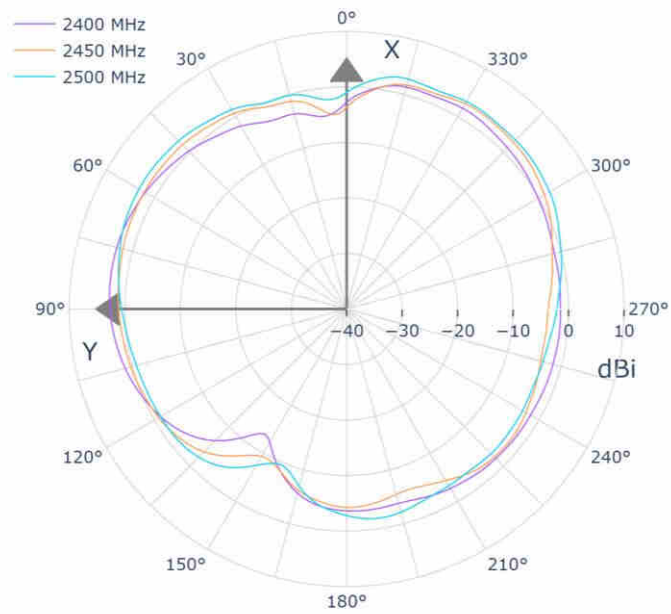
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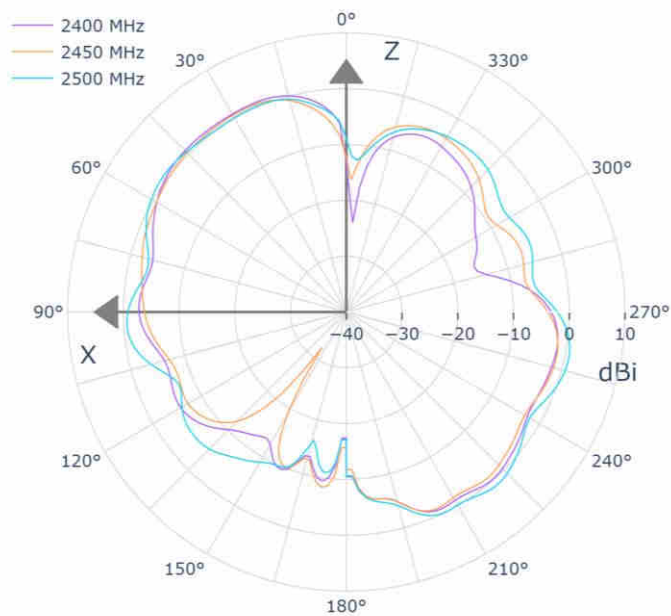
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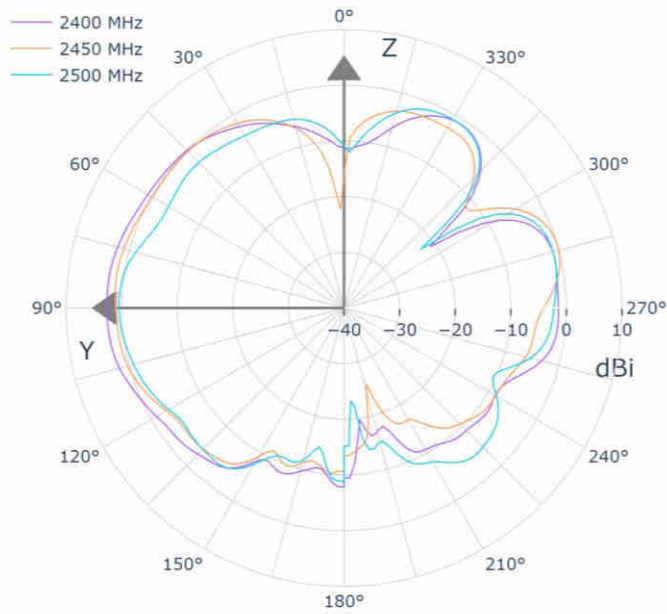
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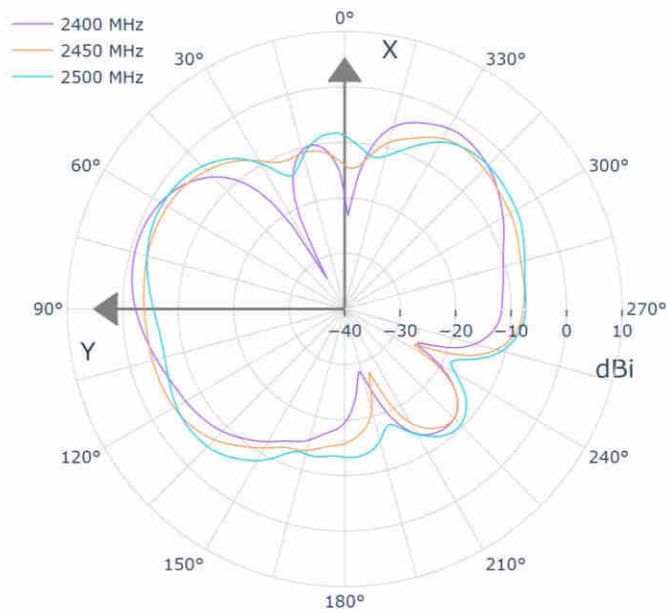
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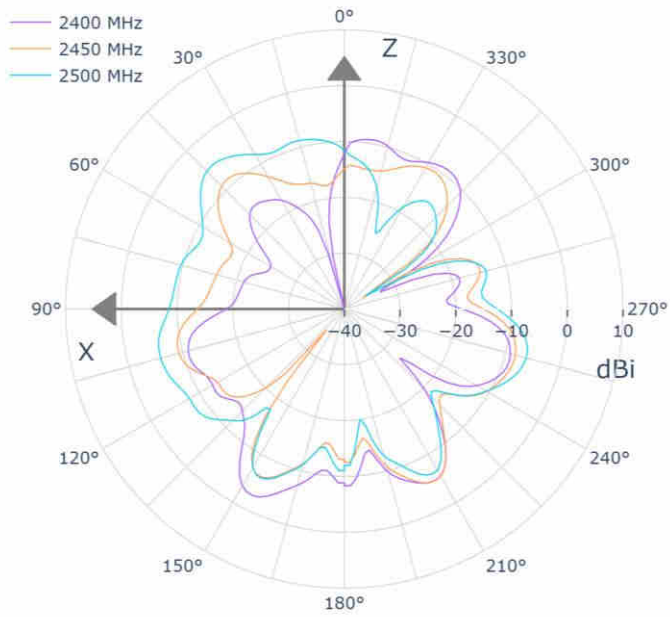
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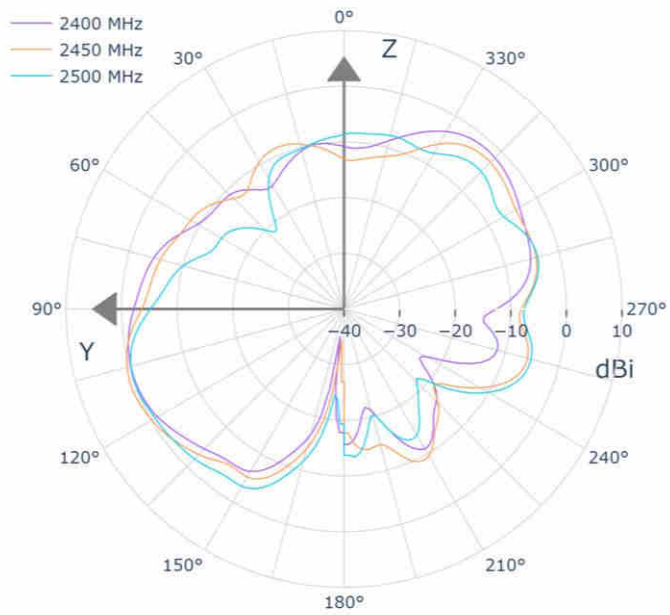
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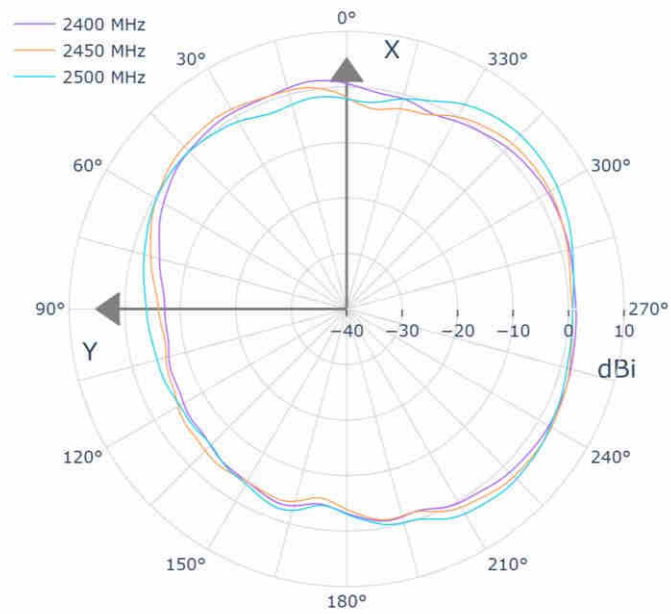
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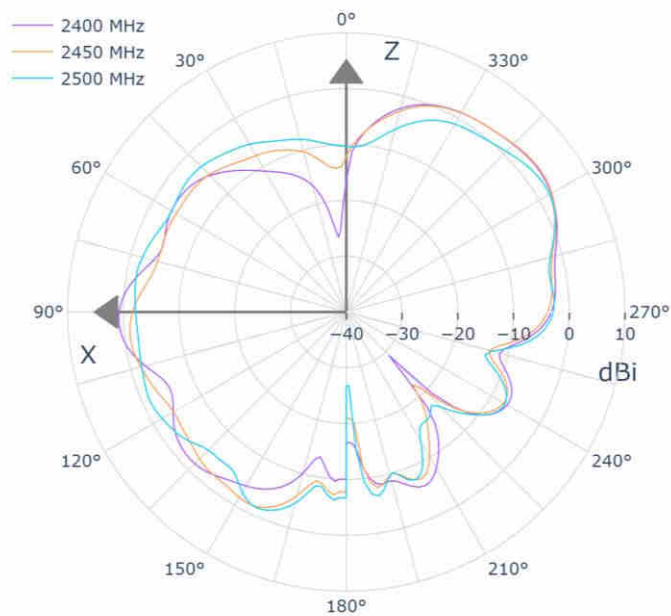
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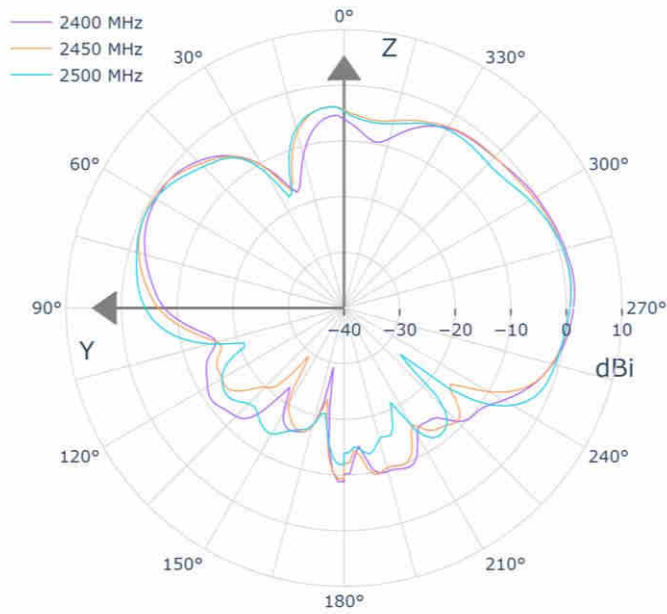
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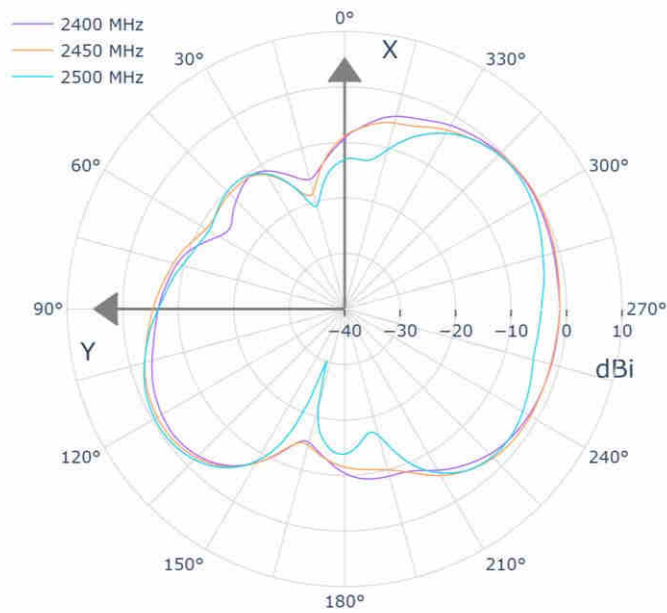
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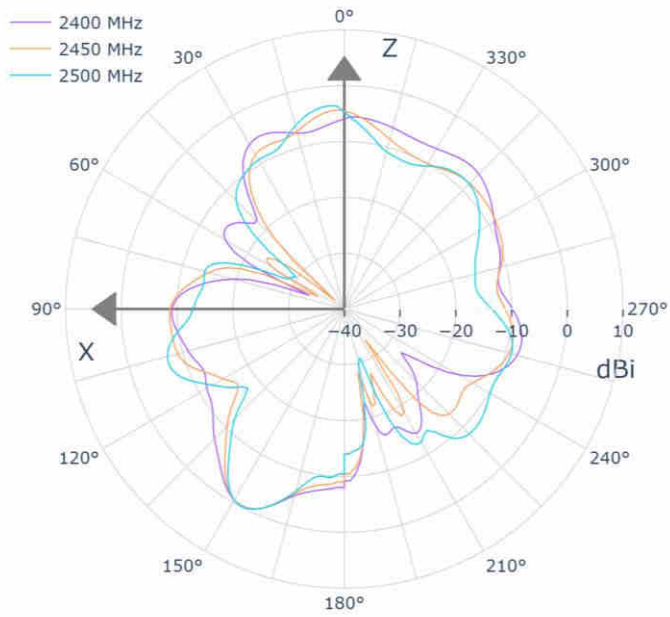
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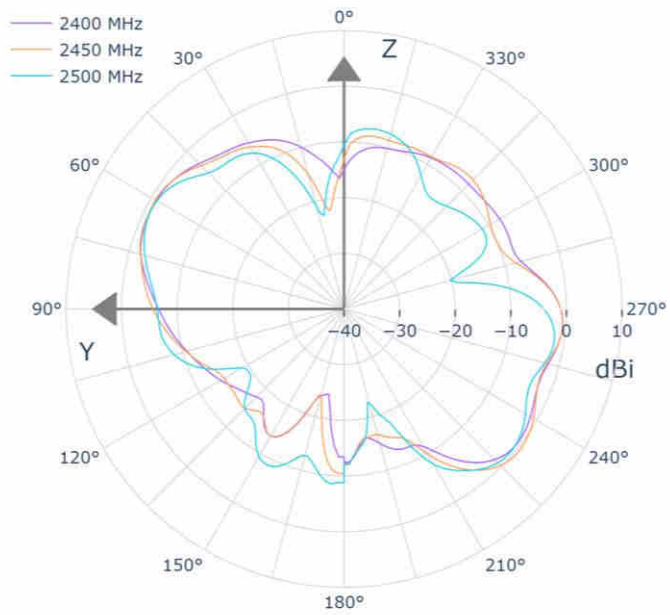
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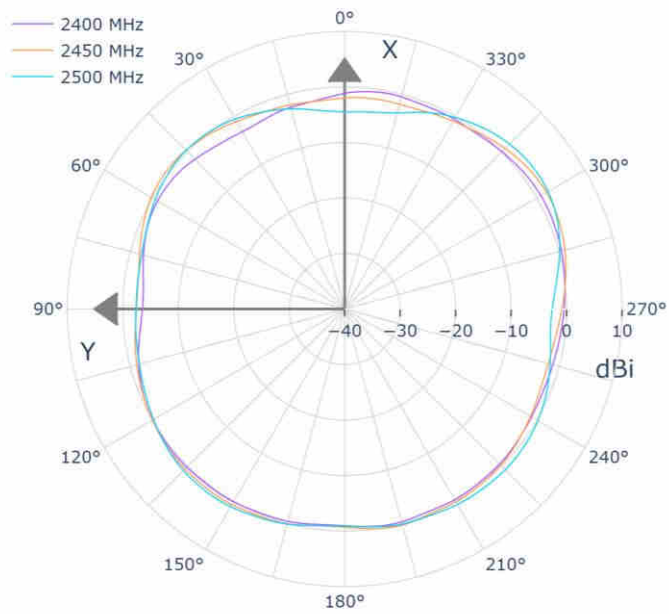
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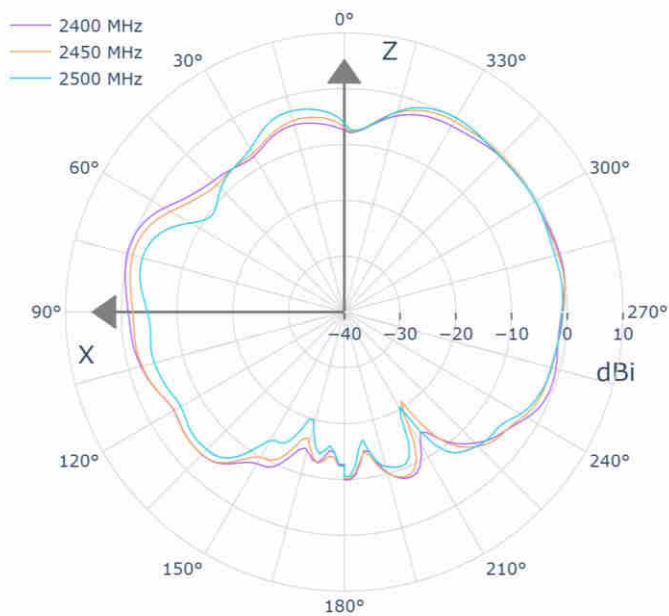
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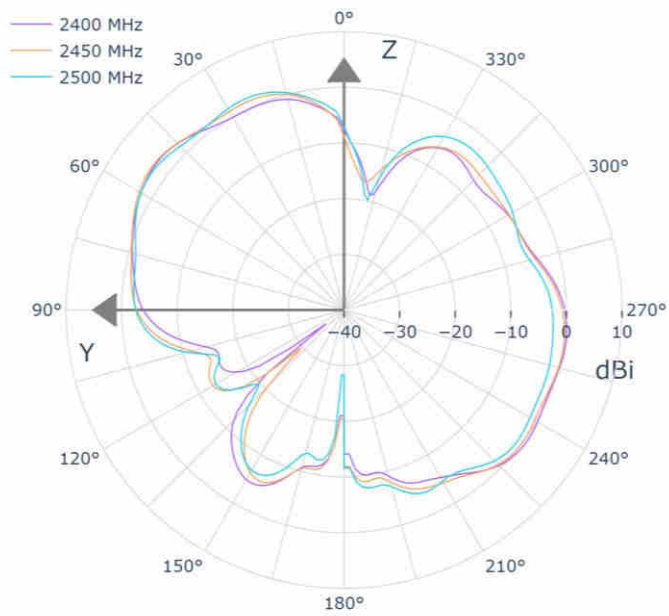
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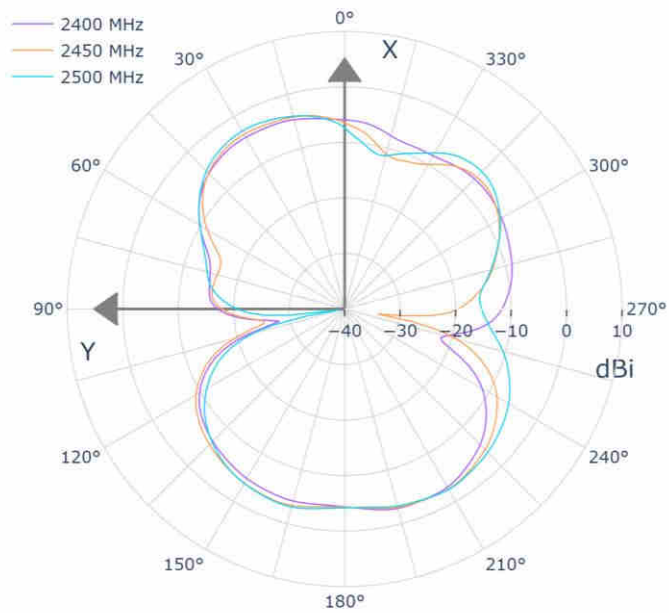
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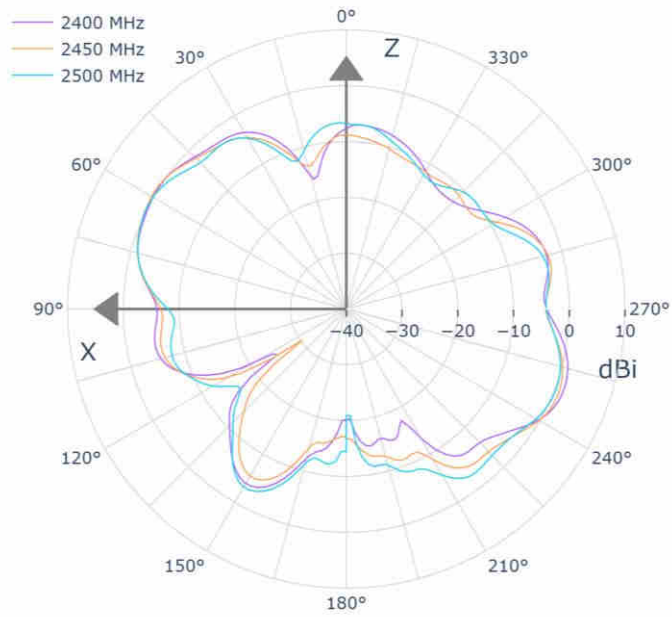
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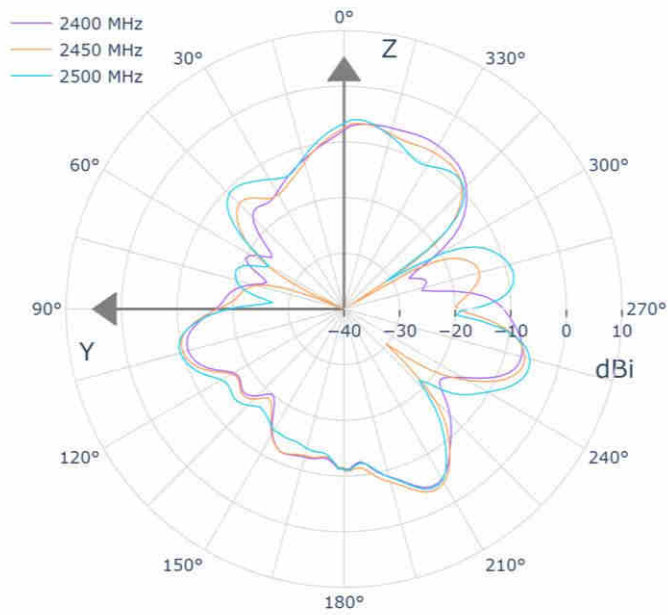
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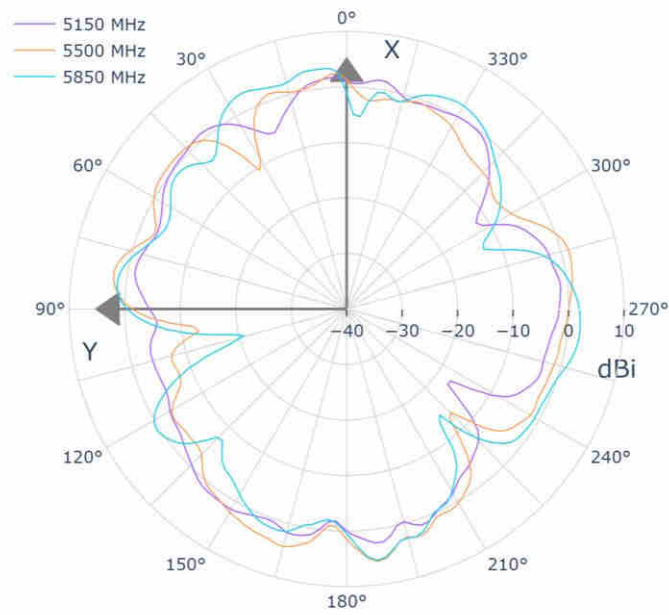


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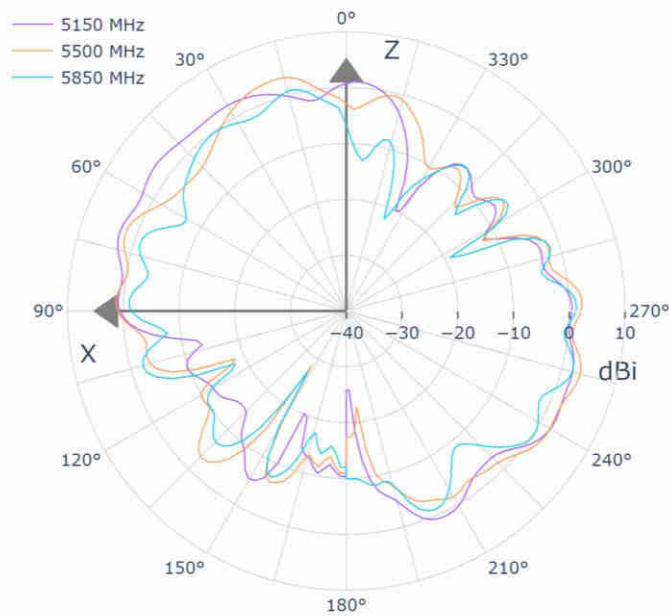


Ant. Position: 5G Ant.5~8

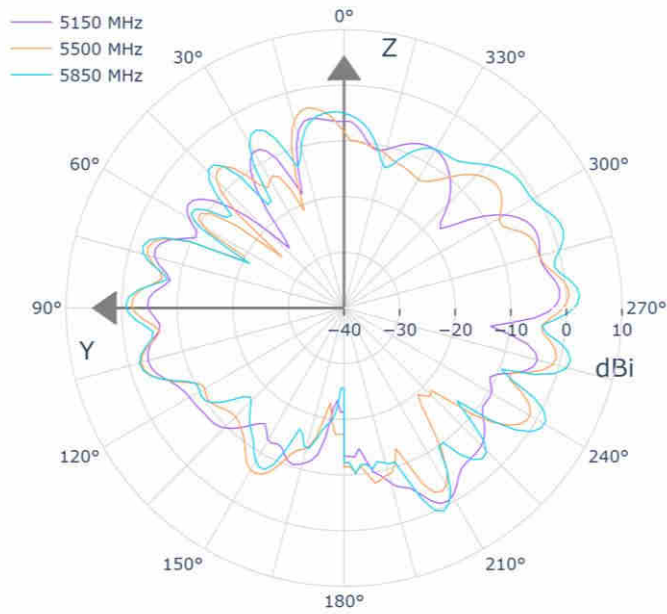
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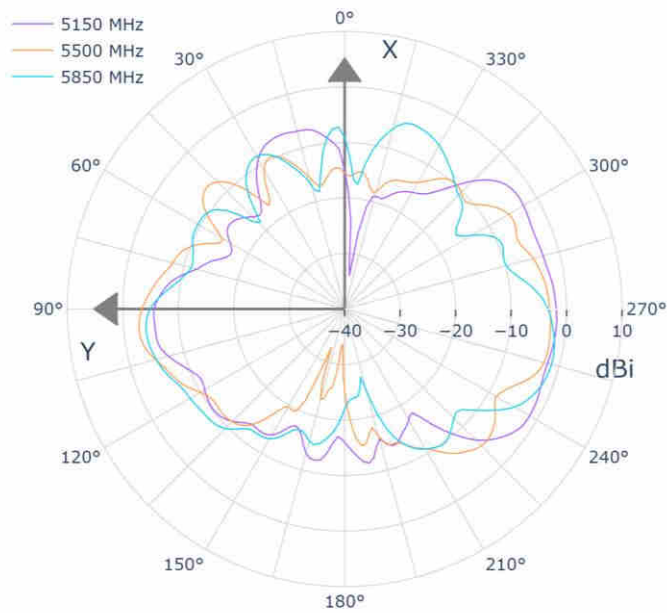
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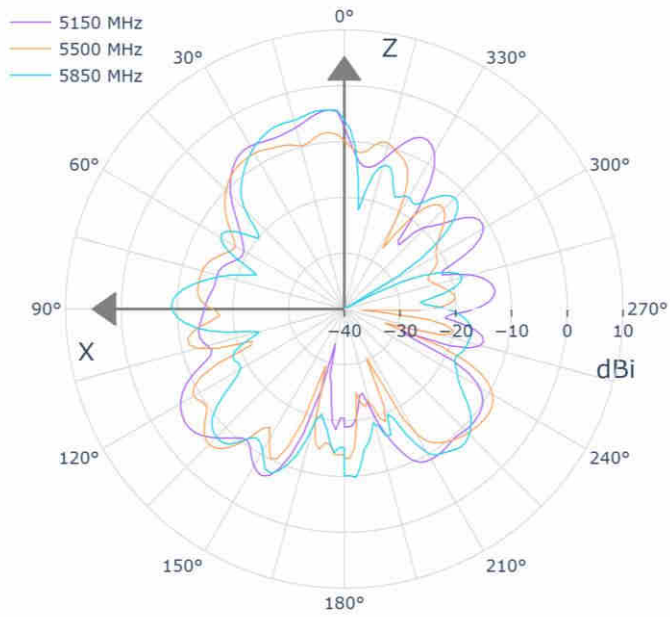
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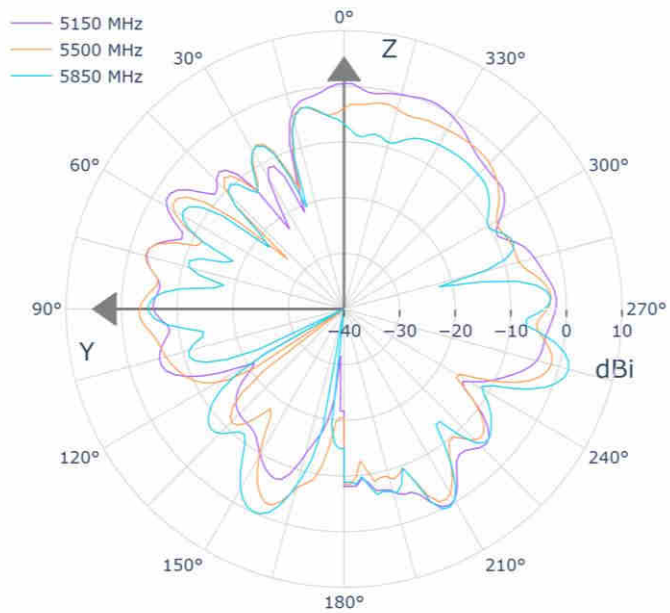
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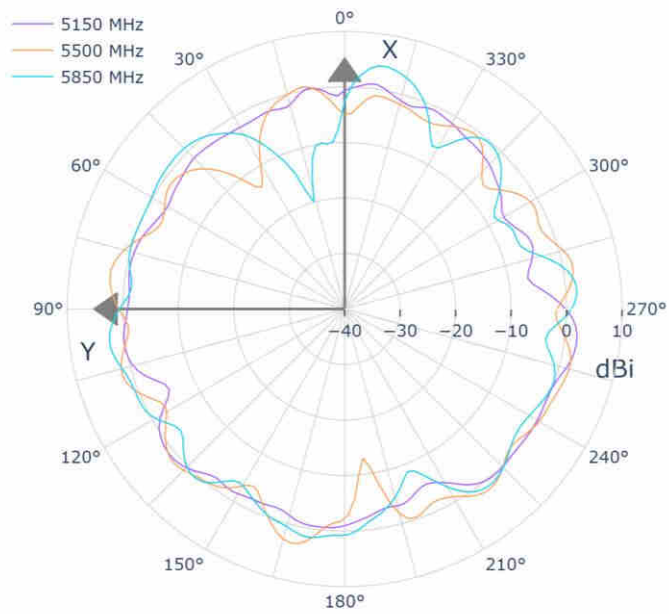
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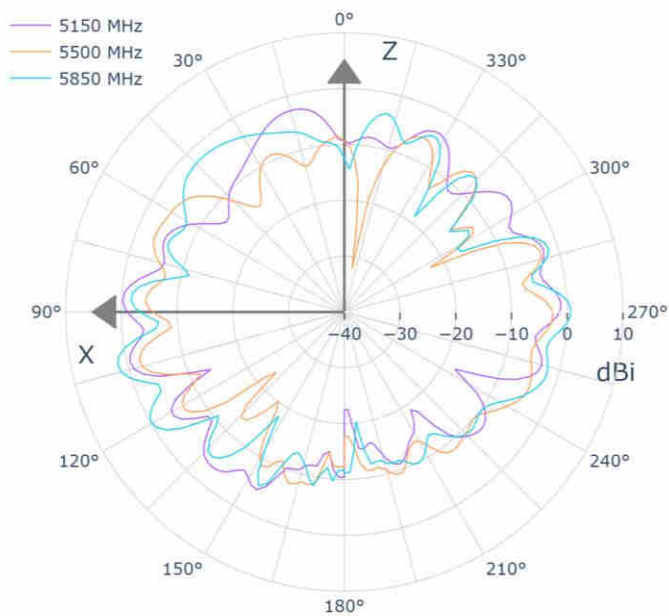
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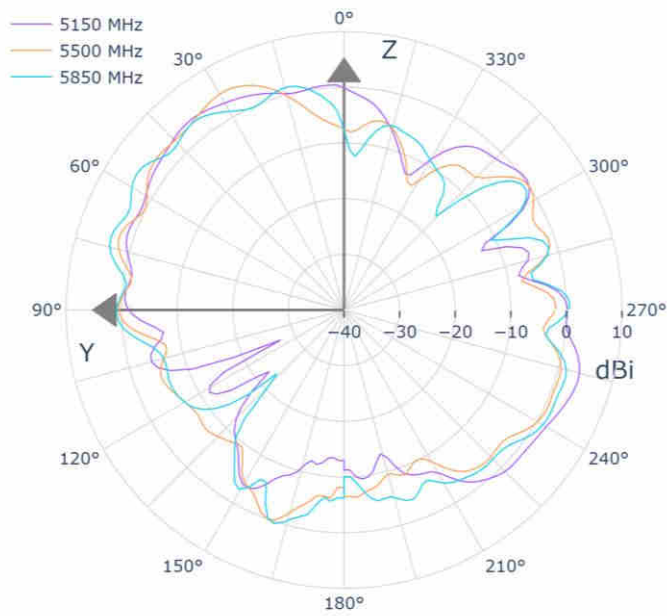
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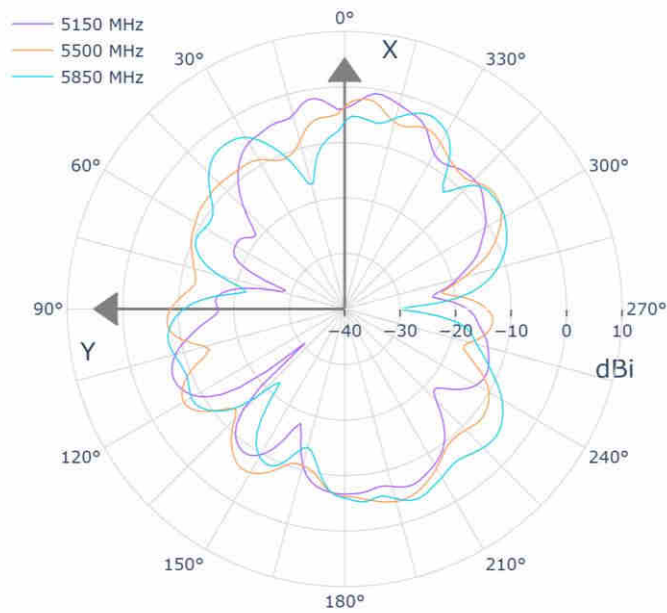
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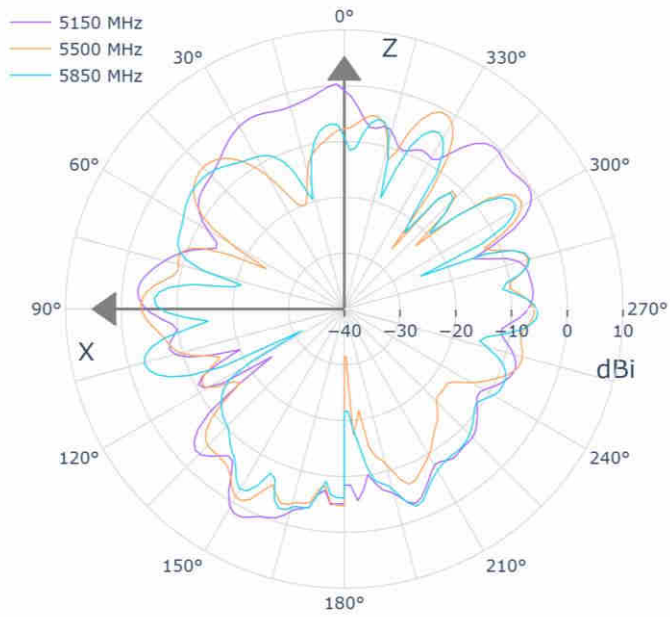
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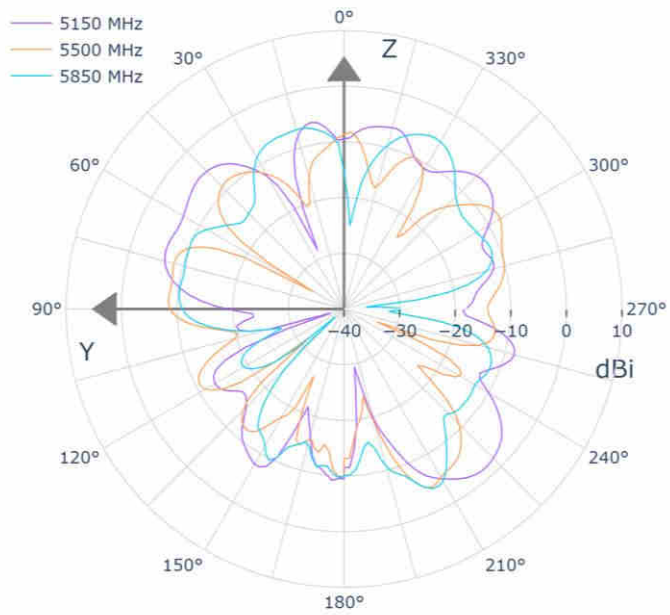
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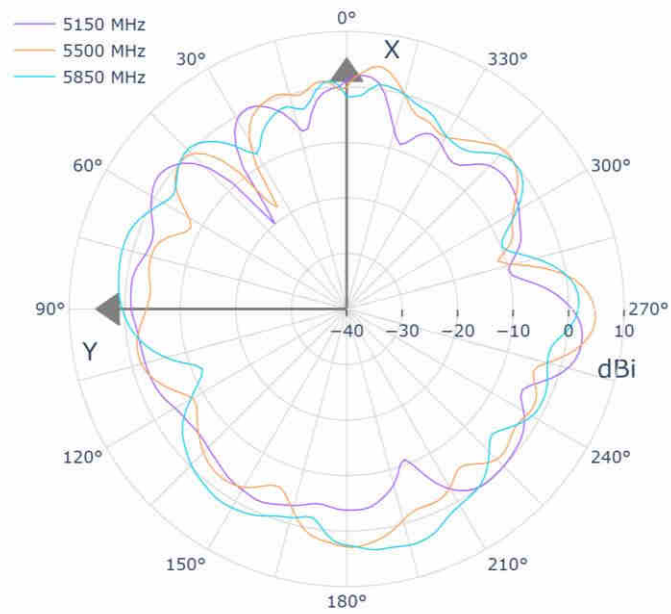
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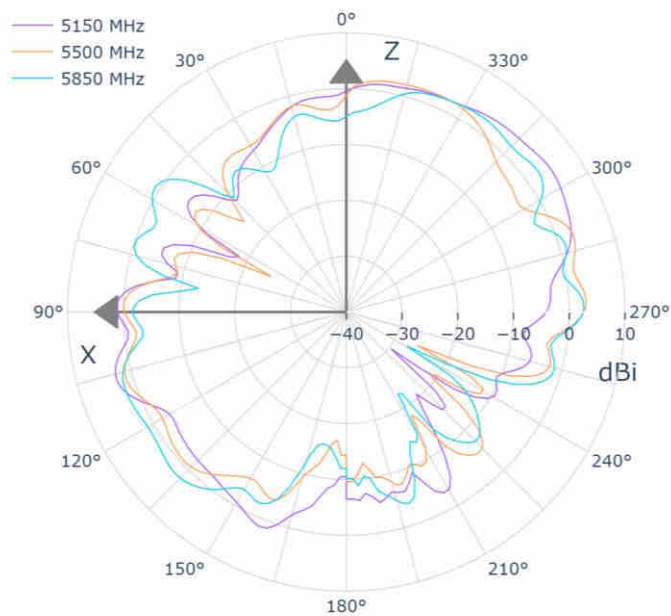
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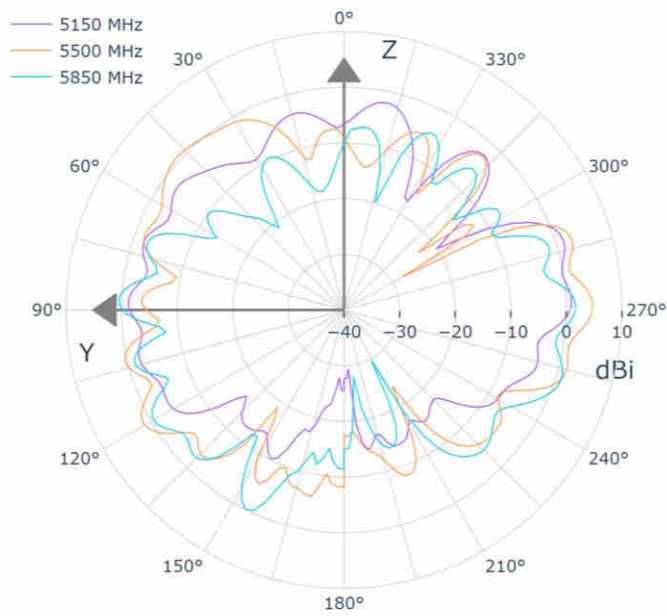
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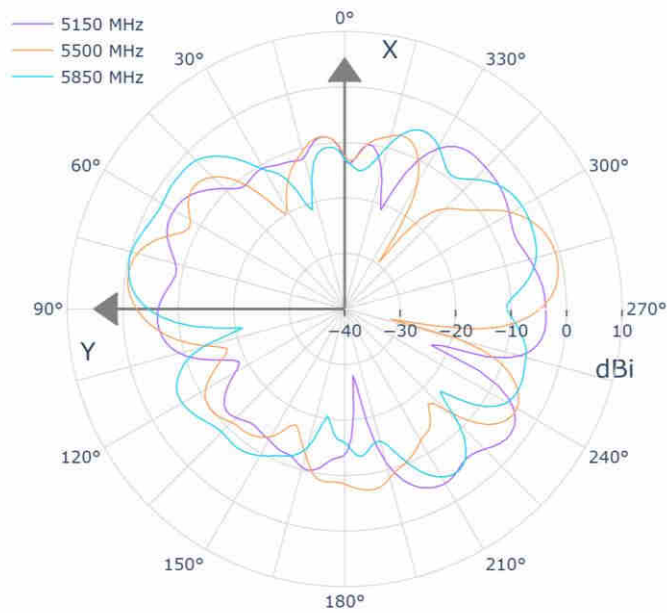
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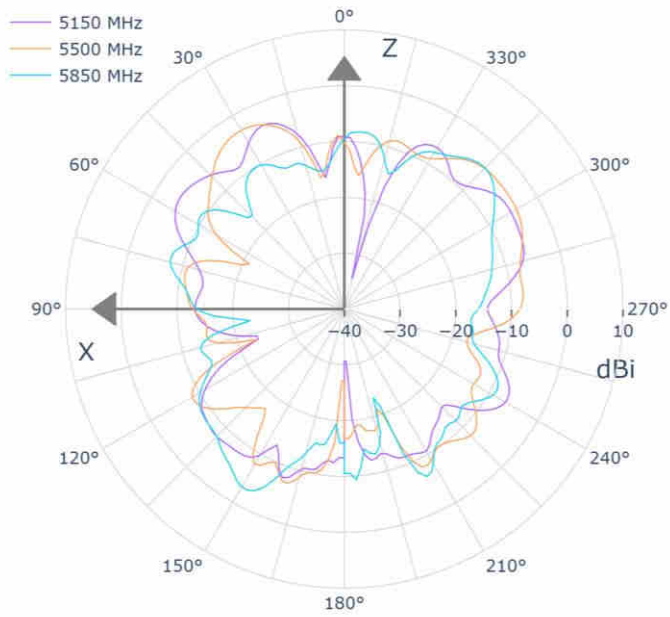
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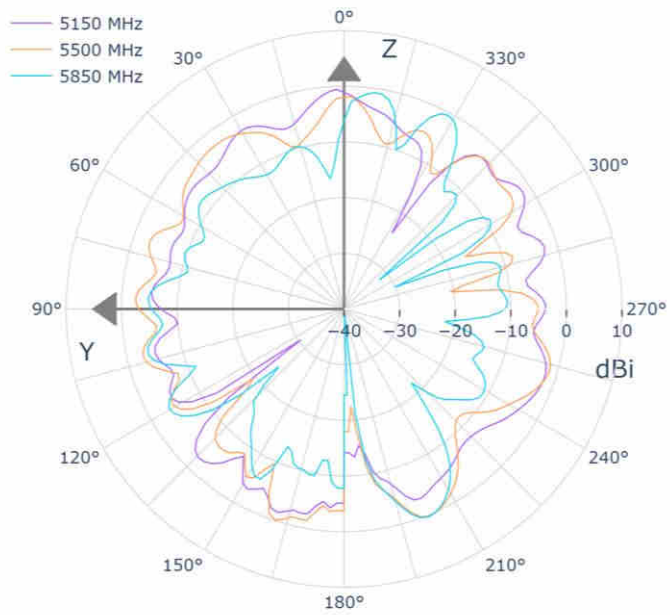
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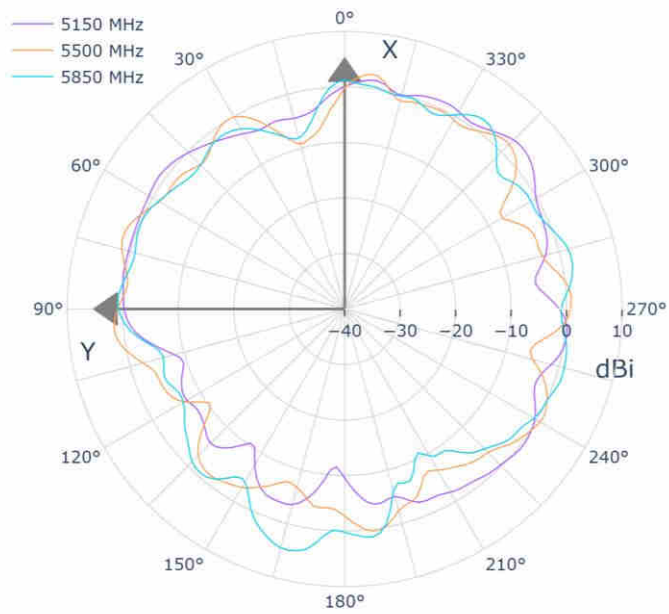
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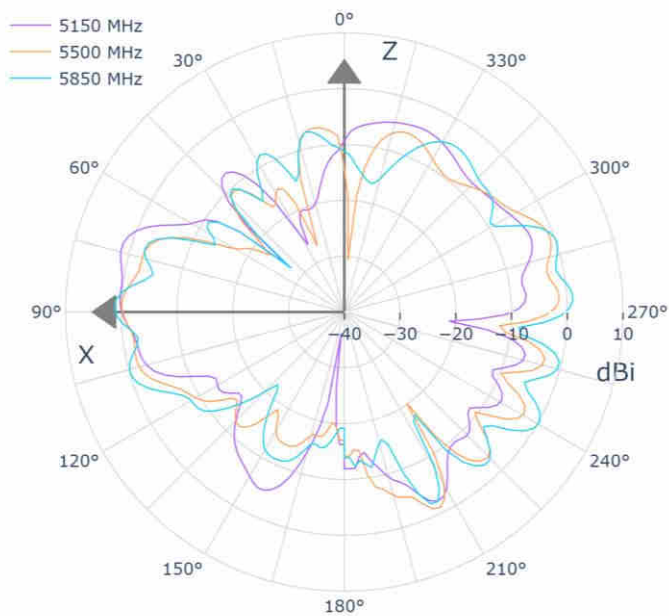
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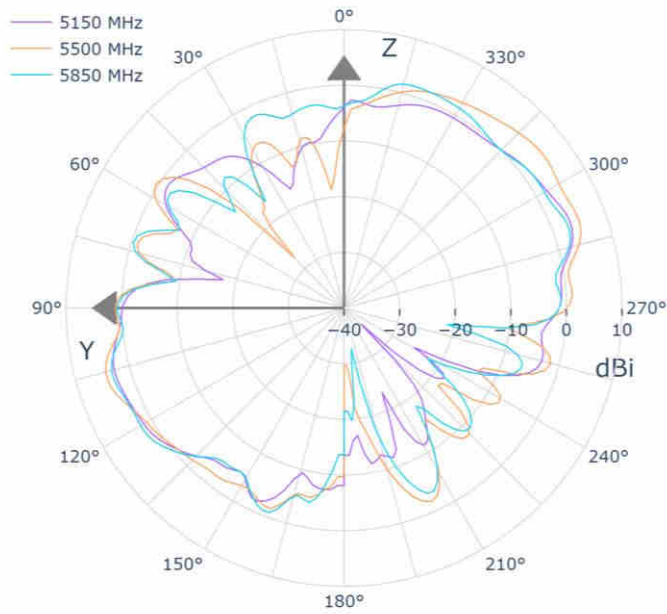
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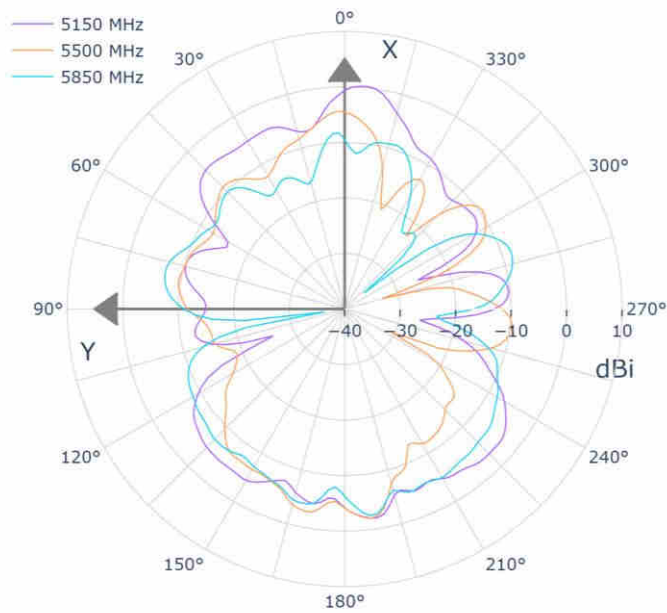
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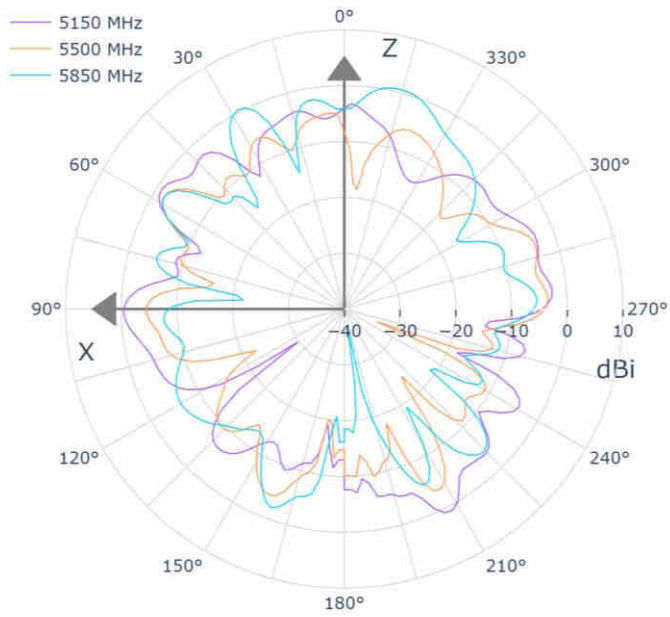
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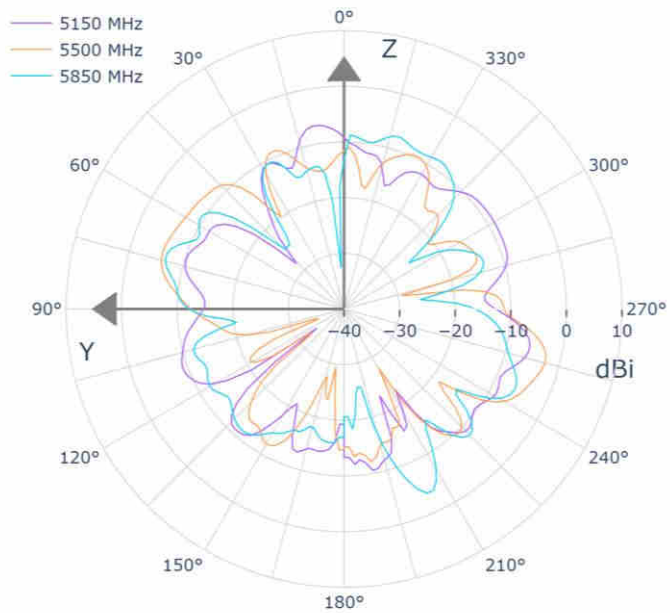
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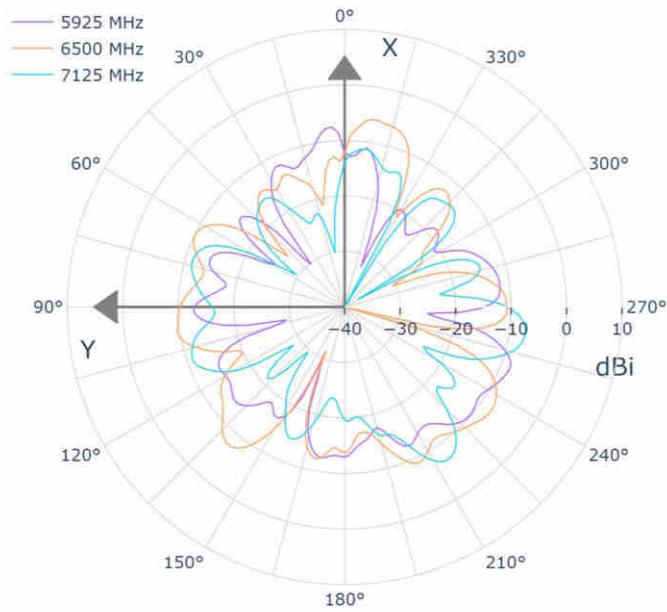
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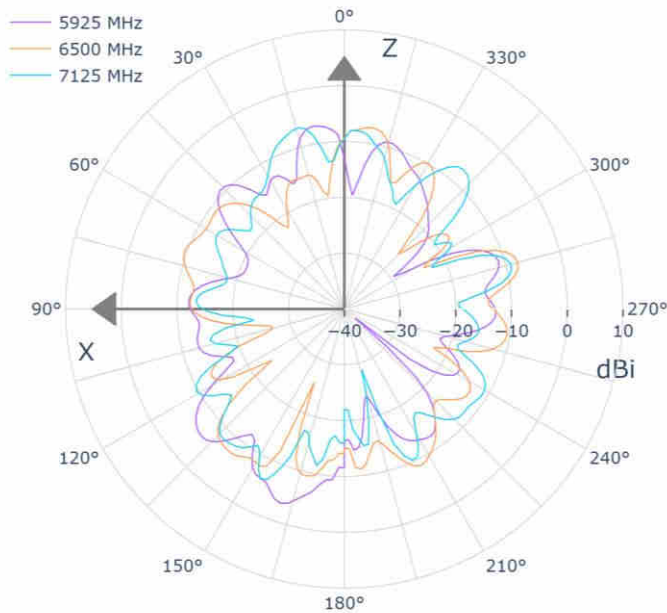
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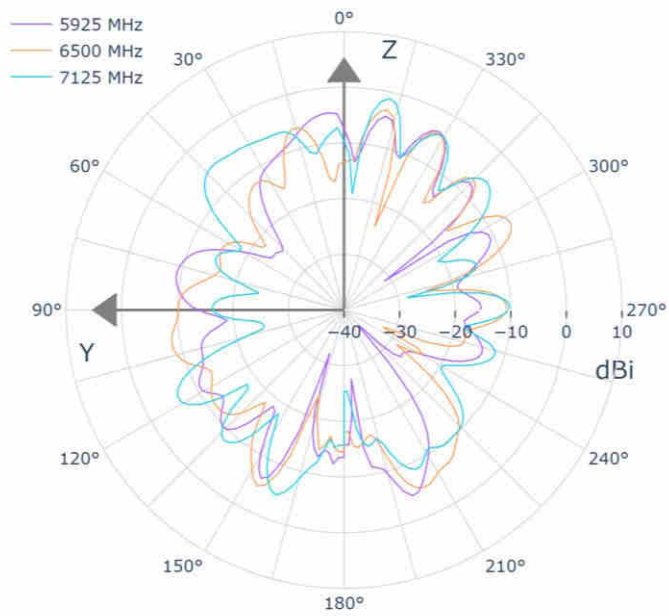
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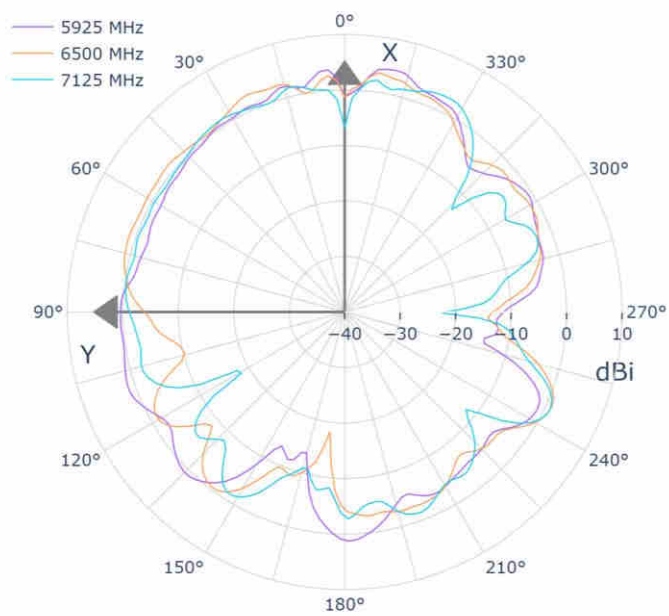
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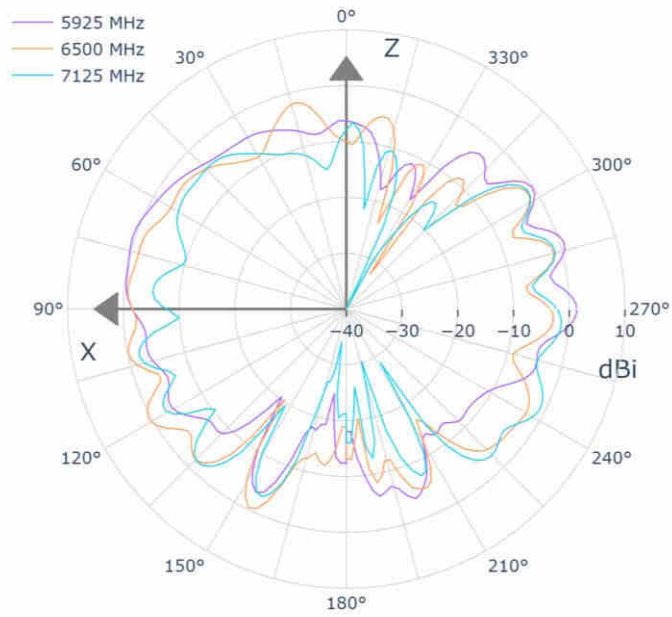
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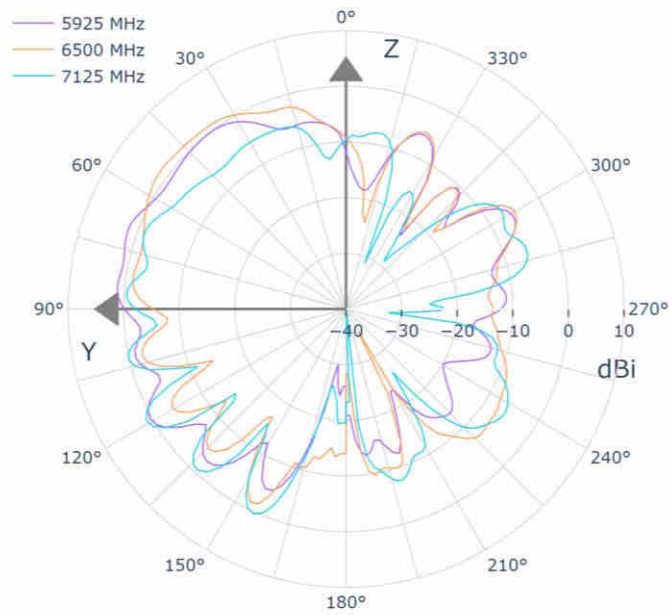
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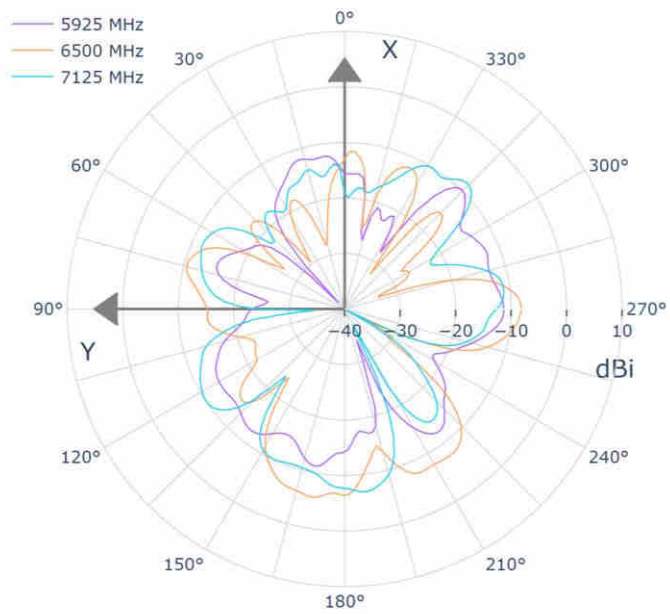
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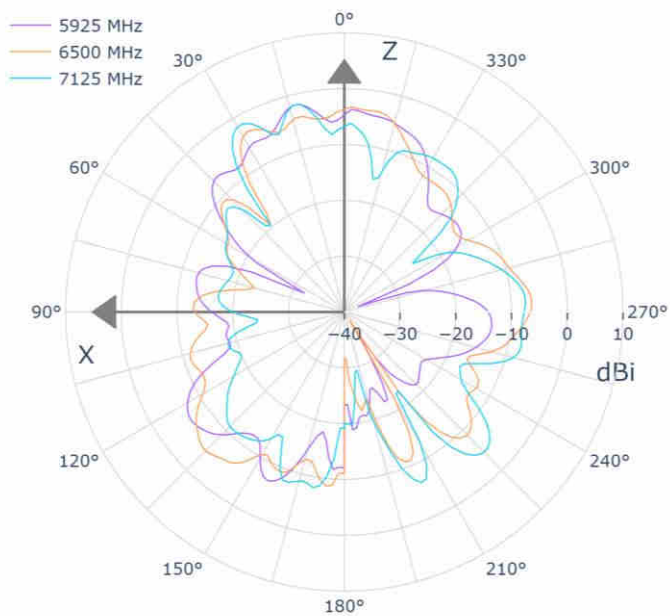
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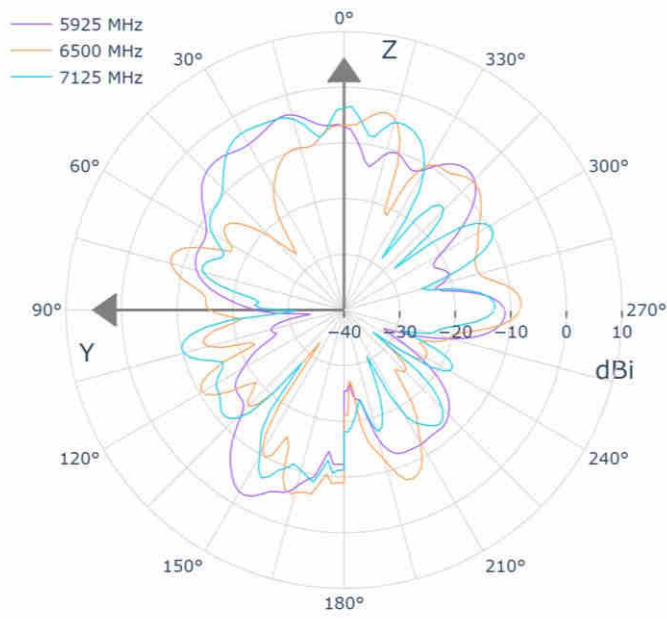
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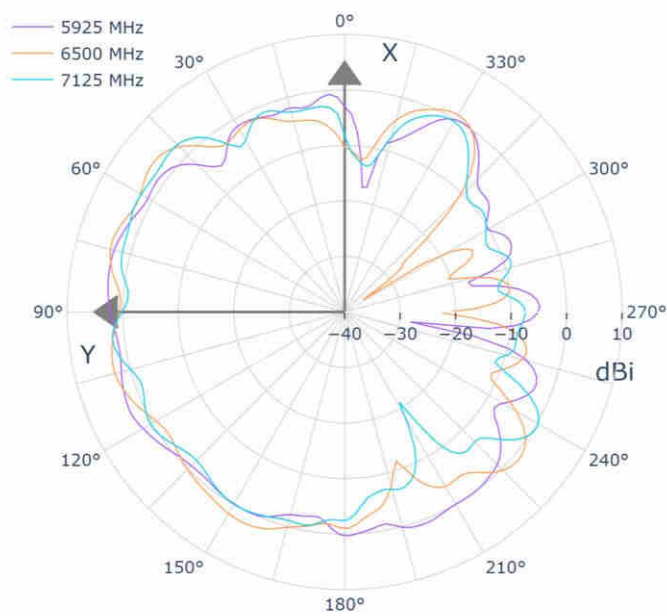
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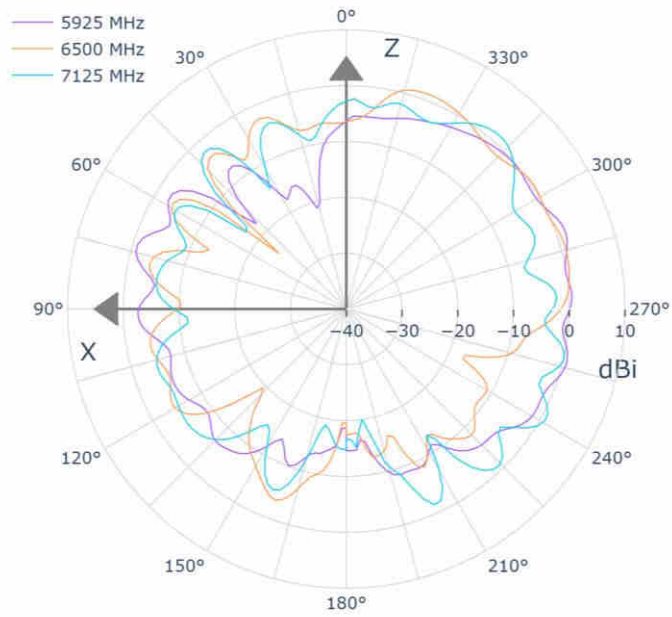
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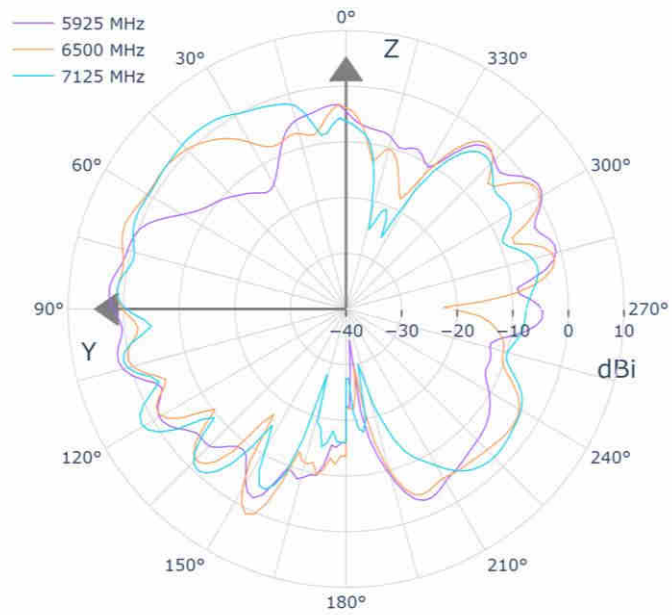
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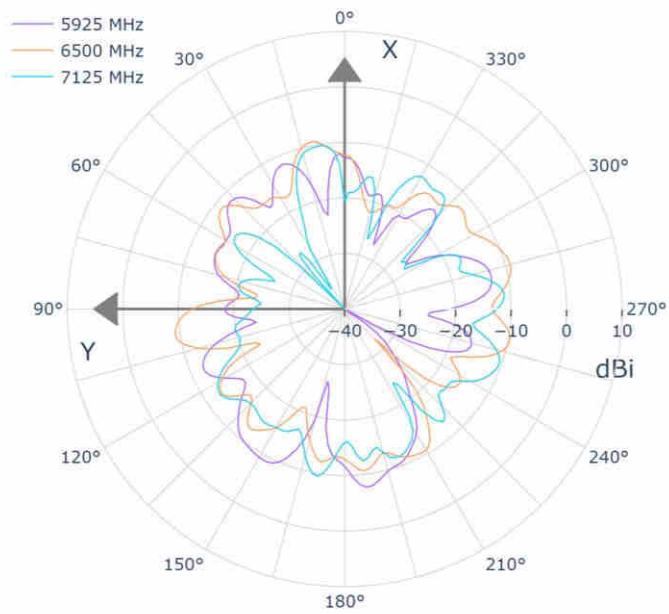
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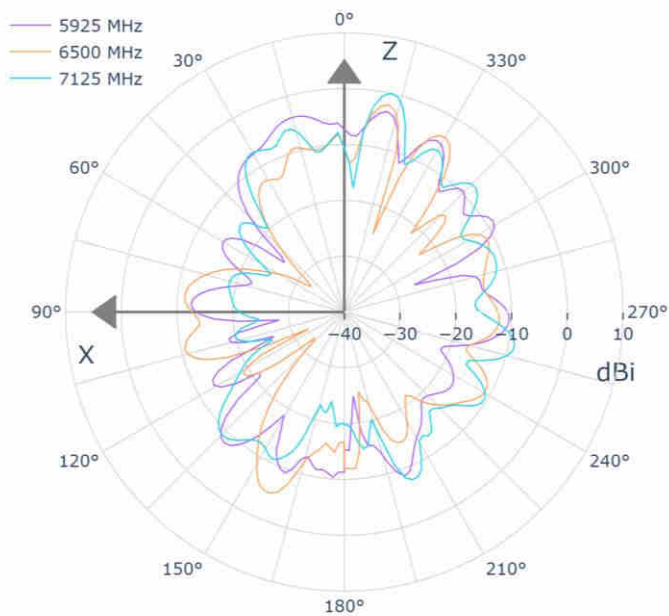
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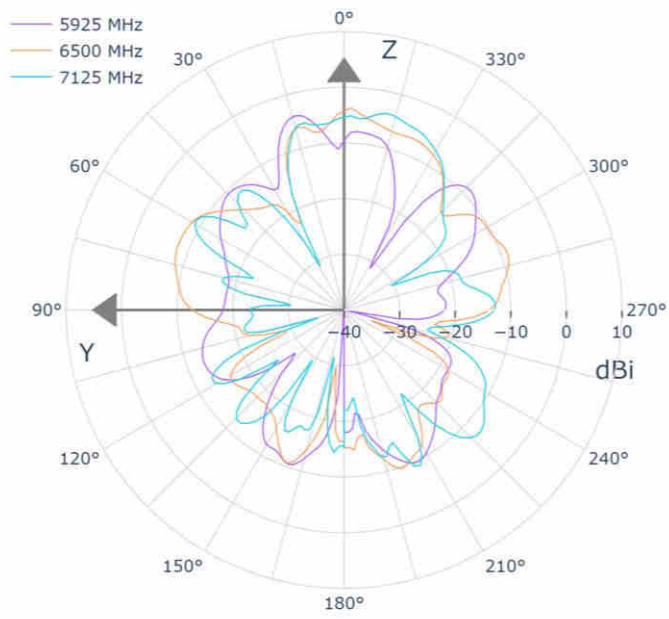
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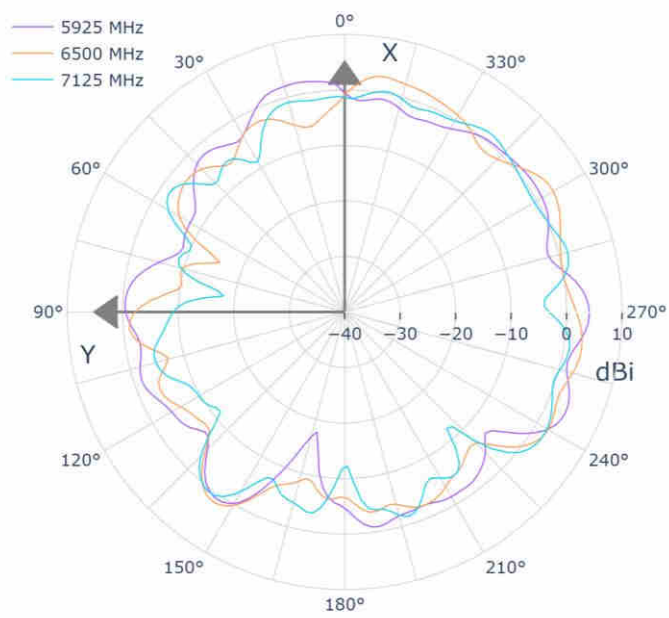
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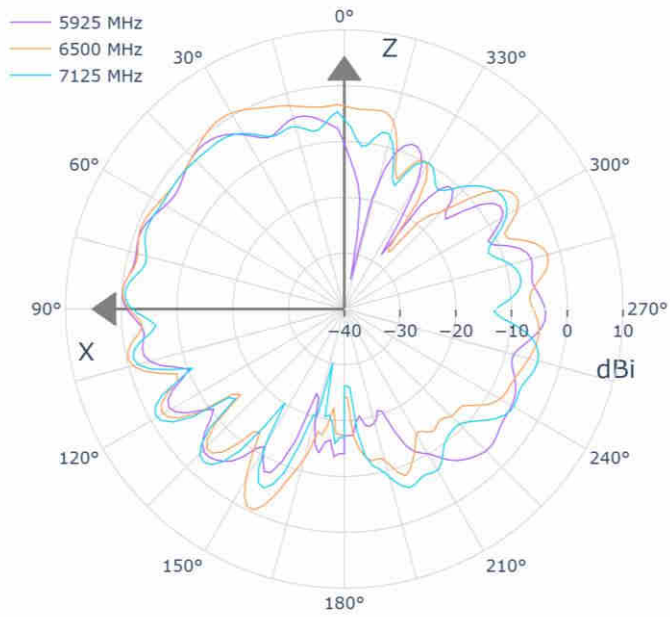
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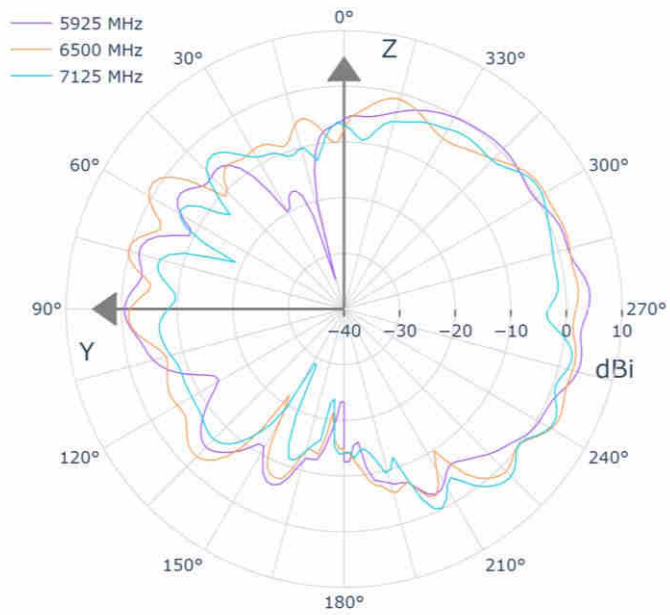
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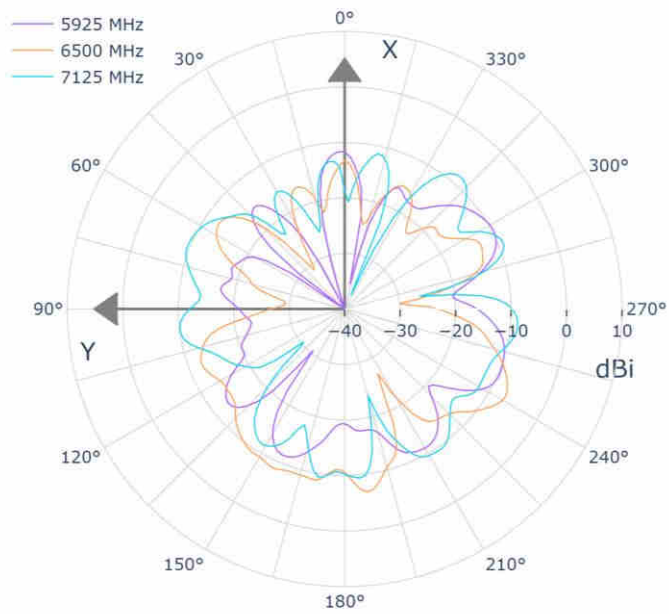
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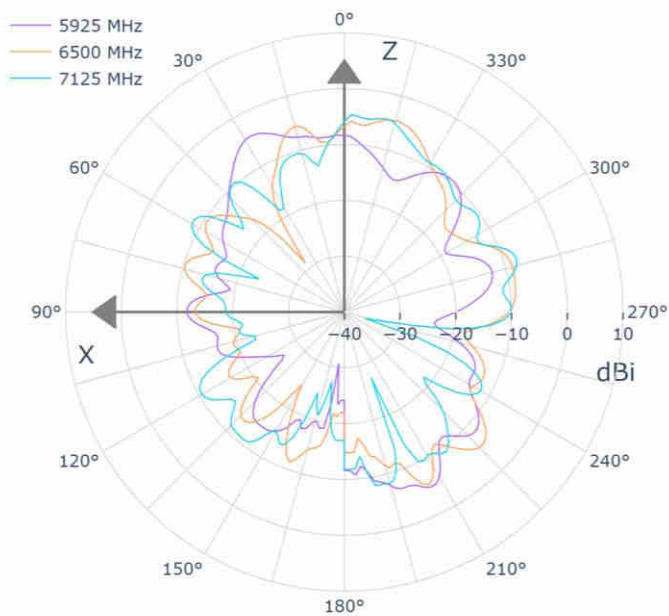
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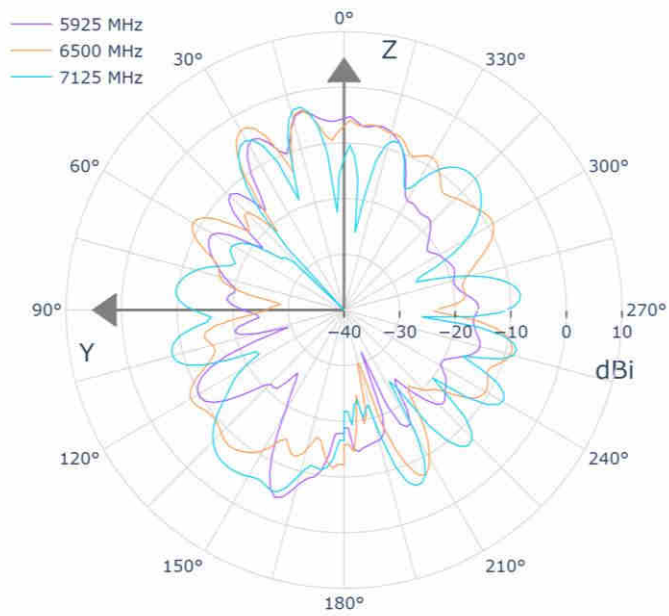
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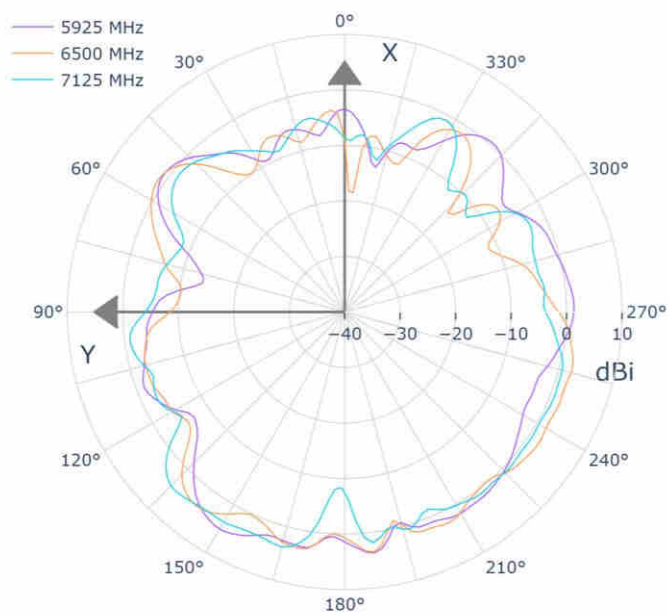
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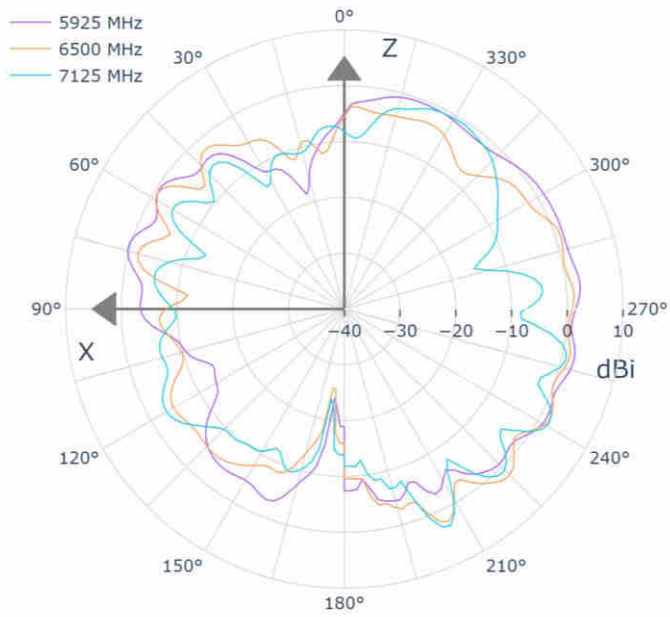
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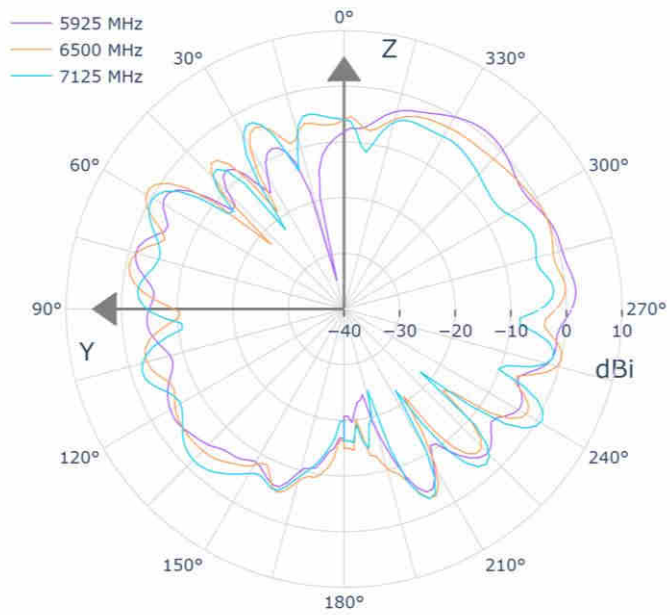
XY_Pol._Theta_Ant.D@6G



XZ_Pol._Theta_Ant.D@5G



YZ_Pol._Phi_Ant.D@6G



Ant. Position: 2.4G Ant.1_GAIN THETA

Table with multiple columns containing numerical data for antenna gain and theta values across various frequencies and positions.

Ant. Position: 2.4G Ant.2_GAIN PHI

8000	8001	8002	8003	8004	8005	8006	8007	8008	8009	8010	8011	8012	8013	8014	8015	8016	8017	8018	8019	8020	8021	8022	8023	8024	8025	8026	8027	8028	8029	8030	8031	8032	8033	8034	8035	8036	8037	8038	8039	8040	8041	8042	8043	8044	8045	8046	8047	8048	8049	8050	8051	8052	8053	8054	8055	8056	8057	8058	8059	8060	8061	8062	8063	8064	8065	8066	8067	8068	8069	8070	8071	8072	8073	8074	8075	8076	8077	8078	8079	8080	8081	8082	8083	8084	8085	8086	8087	8088	8089	8090	8091	8092	8093	8094	8095	8096	8097	8098	8099	8100	8101	8102	8103	8104	8105	8106	8107	8108	8109	8110	8111	8112	8113	8114	8115	8116	8117	8118	8119	8120	8121	8122	8123	8124	8125	8126	8127	8128	8129	8130	8131	8132	8133	8134	8135	8136	8137	8138	8139	8140	8141	8142	8143	8144	8145	8146	8147	8148	8149	8150	8151	8152	8153	8154	8155	8156	8157	8158	8159	8160	8161	8162	8163	8164	8165	8166	8167	8168	8169	8170	8171	8172	8173	8174	8175	8176	8177	8178	8179	8180	8181	8182	8183	8184	8185	8186	8187	8188	8189	8190	8191	8192	8193	8194	8195	8196	8197	8198	8199	8200	8201	8202	8203	8204	8205	8206	8207	8208	8209	8210	8211	8212	8213	8214	8215	8216	8217	8218	8219	8220	8221	8222	8223	8224	8225	8226	8227	8228	8229	8230	8231	8232	8233	8234	8235	8236	8237	8238	8239	8240	8241	8242	8243	8244	8245	8246	8247	8248	8249	8250	8251	8252	8253	8254	8255	8256	8257	8258	8259	8260	8261	8262	8263	8264	8265	8266	8267	8268	8269	8270	8271	8272	8273	8274	8275	8276	8277	8278	8279	8280	8281	8282	8283	8284	8285	8286	8287	8288	8289	8290	8291	8292	8293	8294	8295	8296	8297	8298	8299	8300	8301	8302	8303	8304	8305	8306	8307	8308	8309	8310	8311	8312	8313	8314	8315	8316	8317	8318	8319	8320	8321	8322	8323	8324	8325	8326	8327	8328	8329	8330	8331	8332	8333	8334	8335	8336	8337	8338	8339	8340	8341	8342	8343	8344	8345	8346	8347	8348	8349	8350	8351	8352	8353	8354	8355	8356	8357	8358	8359	8360	8361	8362	8363	8364	8365	8366	8367	8368	8369	8370	8371	8372	8373	8374	8375	8376	8377	8378	8379	8380	8381	8382	8383	8384	8385	8386	8387	8388	8389	8390	8391	8392	8393	8394	8395	8396	8397	8398	8399	8400	8401	8402	8403	8404	8405	8406	8407	8408	8409	8410	8411	8412	8413	8414	8415	8416	8417	8418	8419	8420	8421	8422	8423	8424	8425	8426	8427	8428	8429	8430	8431	8432	8433	8434	8435	8436	8437	8438	8439	8440	8441	8442	8443	8444	8445	8446	8447	8448	8449	8450	8451	8452	8453	8454	8455	8456	8457	8458	8459	8460	8461	8462	8463	8464	8465	8466	8467	8468	8469	8470	8471	8472	8473	8474	8475	8476	8477	8478	8479	8480	8481	8482	8483	8484	8485	8486	8487	8488	8489	8490	8491	8492	8493	8494	8495	8496	8497	8498	8499	8500	8501	8502	8503	8504	8505	8506	8507	8508	8509	8510	8511	8512	8513	8514	8515	8516	8517	8518	8519	8520	8521	8522	8523	8524	8525	8526	8527	8528	8529	8530	8531	8532	8533	8534	8535	8536	8537	8538	8539	8540	8541	8542	8543	8544	8545	8546	8547	8548	8549	8550	8551	8552	8553	8554	8555	8556	8557	8558	8559	8560	8561	8562	8563	8564	8565	8566	8567	8568	8569	8570	8571	8572	8573	8574	8575	8576	8577	8578	8579	8580	8581	8582	8583	8584	8585	8586	8587	8588	8589	8590	8591	8592	8593	8594	8595	8596	8597	8598	8599	8600	8601	8602	8603	8604	8605	8606	8607	8608	8609	8610	8611	8612	8613	8614	8615	8616	8617	8618	8619	8620	8621	8622	8623	8624	8625	8626	8627	8628	8629	8630	8631	8632	8633	8634	8635	8636	8637	8638	8639	8640	8641	8642	8643	8644	8645	8646	8647	8648	8649	8650	8651	8652	8653	8654	8655	8656	8657	8658	8659	8660	8661	8662	8663	8664	8665	8666	8667	8668	8669	8670	8671	8672	8673	8674	8675	8676	8677	8678	8679	8680	8681	8682	8683	8684	8685	8686	8687	8688	8689	8690	8691	8692	8693	8694	8695	8696	8697	8698	8699	8700	8701	8702	8703	8704	8705	8706	8707	8708	8709	8710	8711	8712	8713	8714	8715	8716	8717	8718	8719	8720	8721	8722	8723	8724	8725	8726	8727	8728	8729	8730	8731	8732	8733	8734	8735	8736	8737	8738	8739	8740	8741	8742	8743	8744	8745	8746	8747	8748	8749	8750	8751	8752	8753	8754	8755	8756	8757	8758	8759	8760	8761	8762	8763	8764	8765	8766	8767	8768	8769	8770	8771	8772	8773	8774	8775	8776	8777	8778	8779	8780	8781	8782	8783	8784	8785	8786	8787	8788	8789	8790	8791	8792	8793	8794	8795	8796	8797	8798	8799	8800	8801	8802	8803	8804	8805	8806	8807	8808	8809	8810	8811	8812	8813	8814	8815	8816	8817	8818	8819	8820	8821	8822	8823	8824	8825	8826	8827	8828	8829	8830	8831	8832	8833	8834	8835	8836	8837	8838	8839	8840	8841	8842	8843	8844	8845	8846	8847	8848	8849	8850	8851	8852	8853	8854	8855	8856	8857	8858	8859	8860	8861	8862	8863	8864	8865	8866	8867	8868	8869	8870	8871	8872	8873	8874	8875	8876	8877	8878	8879	8880	8881	8882	8883	8884	8885	8886	8887	8888	8889	8890	8891	8892	8893	8894	8895	8896	8897	8898	8899	8900	8901	8902	8903	8904	8905	8906	8907	8908	8909	8910	8911	8912	8913	8914	8915	8916	8917	8918	8919	8920	8921	8922	8923	8924	8925	8926	8927	8928	8929	8930	8931	8932	8933	8934	8935	8936	8937	8938	8939	8940	8941	8942	8943	8944	8945	8946	8947	8948	8949	8950	8951	8952	8953	8954	8955	8956	8957	8958	8959	8960	8961	8962	8963	8964	8965	8966	8967	8968	8969	8970	8971	8972	8973	8974	8975	8976	8977	8978	8979	8980	8981	8982	8983	8984	8985	8986	8987	8988	8989	8990	8991	8992	8993	8994	8995	8996	8997	8998	8999	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Ant. Position : 2.4G Ant.4_GAIN PH1

Table with 10 columns: Frequency (MHz), Gain (dBi), Phase (deg), and other parameters. The table lists antenna gain data for various frequencies from 2400 to 2484 MHz.

Ant. Position: 6G Ant.A_GAIN PHI

Table with 10 columns: Frequency (MHz), Phi (deg), Gain (dBi), and other parameters. The table contains a dense grid of numerical data for various frequencies and antenna positions.

Ant. Position: 6G Ant.A_GAIN THETA

Table with columns: Frequency (MHz), Gain (dBS), and Theta (degrees). The table contains a dense grid of numerical data points representing antenna gain characteristics across a wide frequency range and various angles.

Ant. Position: 6G Ant.C_GAIN PHI

Table with columns for antenna position (Ant. Pos.), gain (Gain), and phase (Phi). The table contains a dense grid of numerical data points for various antenna configurations.

Ant. Position: 6G Ant.D_GAIN PHI

Table with 10 columns: Frequency (MHz), Phi (deg), Gain (dBi), Phi (deg), Gain (dBi), Phi (deg), Gain (dBi), Phi (deg), Gain (dBi), Phi (deg). The table contains a dense grid of numerical data points for various frequencies and antenna positions.

