

CIG Windstream WF8181/T3280 Antenna Performance

Galtronics Embedded Antenna

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Revision History (Required)

Revisions	Date	Note
S1	October 19, 2022	Initial draft

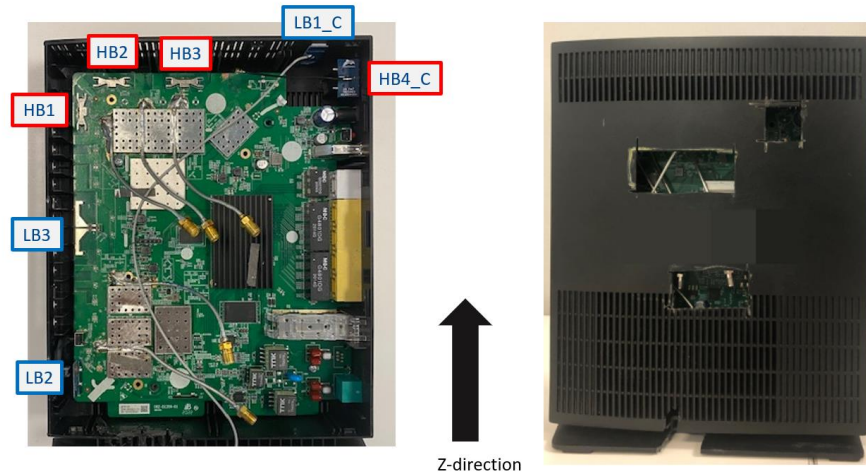
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1. Antenna System Description

There are two cabled antennas (LB1_C and HB4_C) and five onboard antennas (LB2, LB3, HB1, HB2, HB3).

- 02102073-07333A1 (LB1_C): 5GHz Band WiFi Balanced PCB antenna that operates in 5150-5830 MHz Band. It provides high efficient radiation with good cost benefits. It is cable fed and can be heat-staked on the customer enclosure. The antenna has a coax cable that is terminated with U.FL-style connector.
- 02036073-7333B1 (LB2): 2.5 GHz Band WiFi Onboard antenna that operates in 2400-2500 MHz Band. It provides high efficient radiation with good cost benefits. The antenna is mounted on a PCB with corresponding footprint and a 50 ohms transmission line. A Pi matching network should be placed between the radio and antenna feed pad.
- 02036073-05853 (LB3): 2.5 GHz Band WiFi Onboard antenna that operates in 2400-2500 MHz Band. It provides high efficient radiation with good cost benefits. The antenna is mounted on a PCB with corresponding footprint and a 50 ohms transmission line. A Pi matching network should be placed between the radio and antenna feed pad.
- 02036142-05853 (HB1): 5GHz Band WiFi Onboard antenna that operates in 5150-5830 MHz Band. It provides high efficient radiation with good cost benefits. The antenna is mounted on a PCB with corresponding footprint and a 50 ohms transmission line. A Pi matching network should be placed between the radio and antenna feed pad.
- 02036142-05853 (HB2): 5GHz Band WiFi Onboard antenna that operates in 5150-5830 MHz Band. It provides high efficient radiation with good cost benefits. The antenna is mounted on a PCB with corresponding footprint and a 50 ohms transmission line. A Pi matching network should be placed between the radio and antenna feed pad.
- 02036142-05853 (HB3): 5GHz Band WiFi Onboard antenna that operates in 5150-5830 MHz Band. It provides high efficient radiation with good cost benefits. The antenna is mounted on a PCB with corresponding footprint and a 50 ohms transmission line. A Pi matching network should be placed between the radio and antenna feed pad.
- 02102142-07333 (HB4_C): 5GHz Band WiFi Balanced PCB antenna that operates in 5150-5830 MHz Band. It provides high efficient radiation with good cost benefits. The antenna is mounted using foam tape on the customer device. The antenna has a coax cable that is terminated with U.FL-style connector.



2. Measurement Quantity

The antennas were tested in full in an enclosure

- 02102073-07333A1 (LB1_C): Peak gain -- 3.47 dBi at 2500 MHz
- 02036073-7333B1 (LB2): Peak gain – 4.91 dBi at 2500 MHz
- 02036073-05853 (LB3): Peak gain – 4.23 dBi at 2500 MHz
- 02036142-05853 (HB1): Peak gain -- 4.70 dBi at 5350 MHz
- 02036142-05853 (HB2): Peak gain – 5.43 dBi at 5725 MHz
- 02036142-05853 (HB3): Peak gain – 4.61 dBi at 5725 MHz
- 02102142-07333 (HB4_C): Peak gain – 3.34 dBi at 5825 MHz

2-1. Correlated/Un-Correlated directional gain equation

Unequal antenna gains, with equal transmit powers. For antenna gains given by G_1, G_2, \dots, G_N dBi

(i) If transmit signals are *correlated*, then

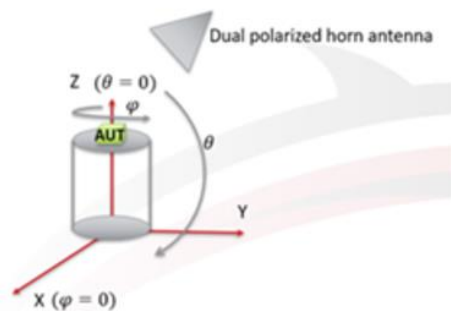
Directional gain = $10 \log[(10^{G_1/20} + 10^{G_2/20} + \dots + 10^{G_N/20})^2 / N_{ANT}]$ dBi [Note the “20”s in the denominator of each exponent and the square of the sum of terms; the object is to combine the signal levels coherently.]

(ii) If all transmit signals are *completely uncorrelated*, then

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

3. Measurement Method

The measurement setup is a spherical near-field scanner. The scanner system is housed in an integral/shielded anechoic chamber. The antenna under test (AUT) is mounted at the center of the chamber on an entirely foam pedestal. The pedestal rotates horizontally in the Azimuth (Φ). A wideband dual polarized horn antenna (probe) is mounted at a fixed distance away from the center of the chamber. The probe rotates along the elevation angle (Θ) and measures the radiation from the AUT. The measurement in the azimuth plane provides 360-degree of rotation whereas in the elevation plane it provides 180-degree of rotation. A software is used for post processing the measured data and calculate the far-field parameters including gain, directivity, and efficiency of the antenna.



4. Measurement Environment

Galtronics, USA use Howland 7200S Near Field anechoic chamber designed to interface with Howland Wireless Test Lab (WTL) is used to control the chamber hardware for antenna pattern measurements. Processing measurement scan results and generation of 'Far Field' and 'Gain & Directivity' files are done using Howland Spherical N2F software. The anechoic Chamber is 14'W x 16'H x 16'D without absorbers.

The DUT is placed on an NSI turntable (Phi Axis) in the center of the anechoic Chamber and 96" from the chamber floor. A probe is mounted on the theta axis. The probe used by Galtronics, USA is a Howland QR1, broadband, dual-polarization horn antenna operating in 700MHz to 10GHz. Theta and Phi axis are controlled by the Motion Control Unit from The Howland Company

The Chamber operates from 698MHz-7.5GHz. A Rohde & Schwarz ZVB8 Vector network analyzer (VNA) is used to generate and measure the RF signal fed through the DUT and the Probe antenna. The VNA is controlled by Howland WTL software in remote control mode.

The Chamber is validated periodically to ensure accuracy in antenna pattern measurements.



A photograph of two dolphins leaping from the ocean at sunset. The dolphins are in mid-air, their bodies curved as they move from left to right. The sun is low on the horizon, creating a bright, golden glow that illuminates the sky and the water. The sky is filled with soft, wispy clouds, and the water below shows gentle ripples. The overall mood is serene and dynamic.

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CIG WindStream T3280 Antenna Performance

Galtronics Project: 7333A

Prepared by Junho Cha
July 31st , 2020

Introduction



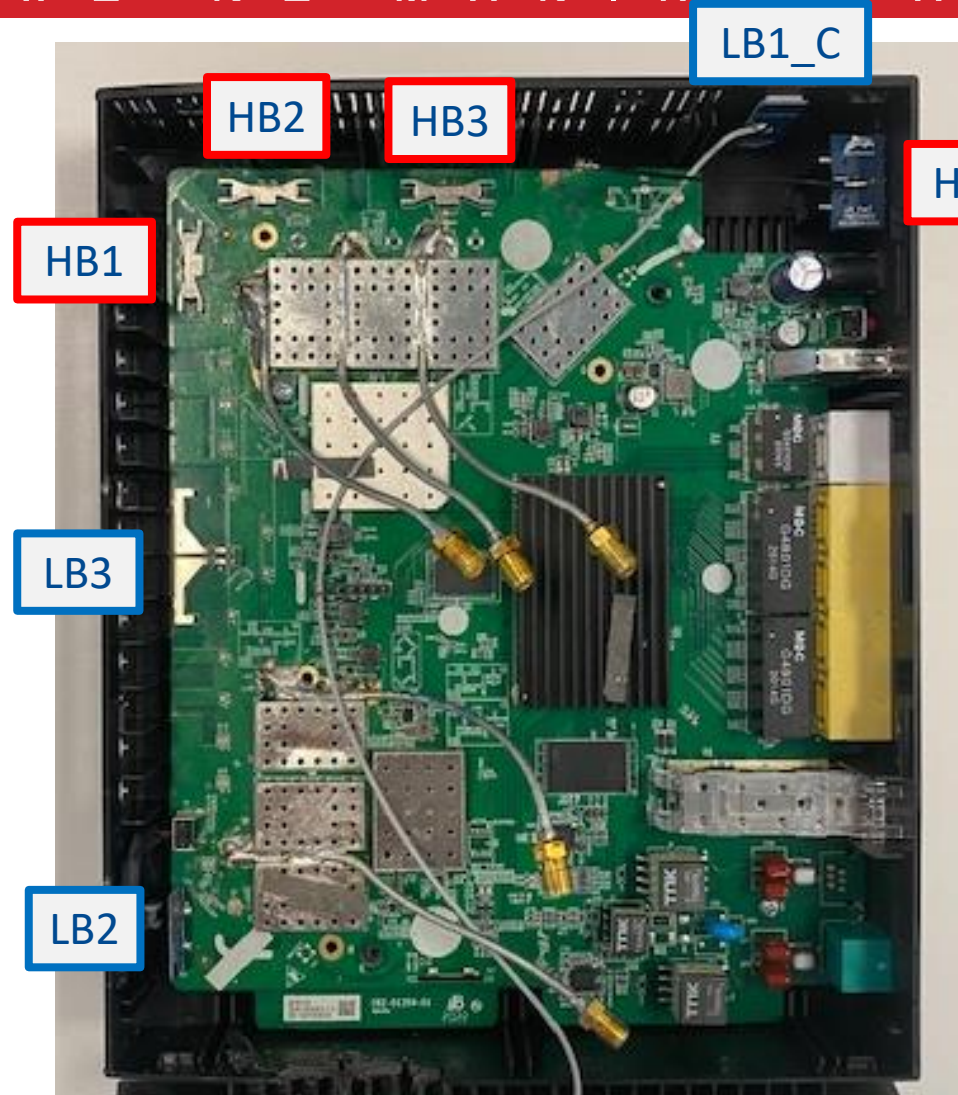
W E ' R E M A K I N G W A V E S ™

- » Galtronics developed an antenna solution for CIG WindStream T3280
- » Galtronics received the new Hardware from CIG
- » There are two cabled antennas (LB1_C and HB4_C) and Five onboard (LB2, LB3, HB1, HB2, HB3) antennas
- » LB1_C and HB4_C are PCB cabled antennas and DC-grounded antennas.
- » LC matching component values:
 - LB 2 (PCB Onboard) : Add a series inductor (2.7 nH) : Existing component
 - LB 3 (Metal Onboard) : Add a shunt capacitor (1 pF) and a series inductor (1.5 nH) : Existing component
 - HB 3 (Metal Onboard) : 0 Ohm resistor : Updated component
- » Measured return loss, isolation, peak gain, efficiency, composite gain and gain pattern of the antennas

Antenna Location

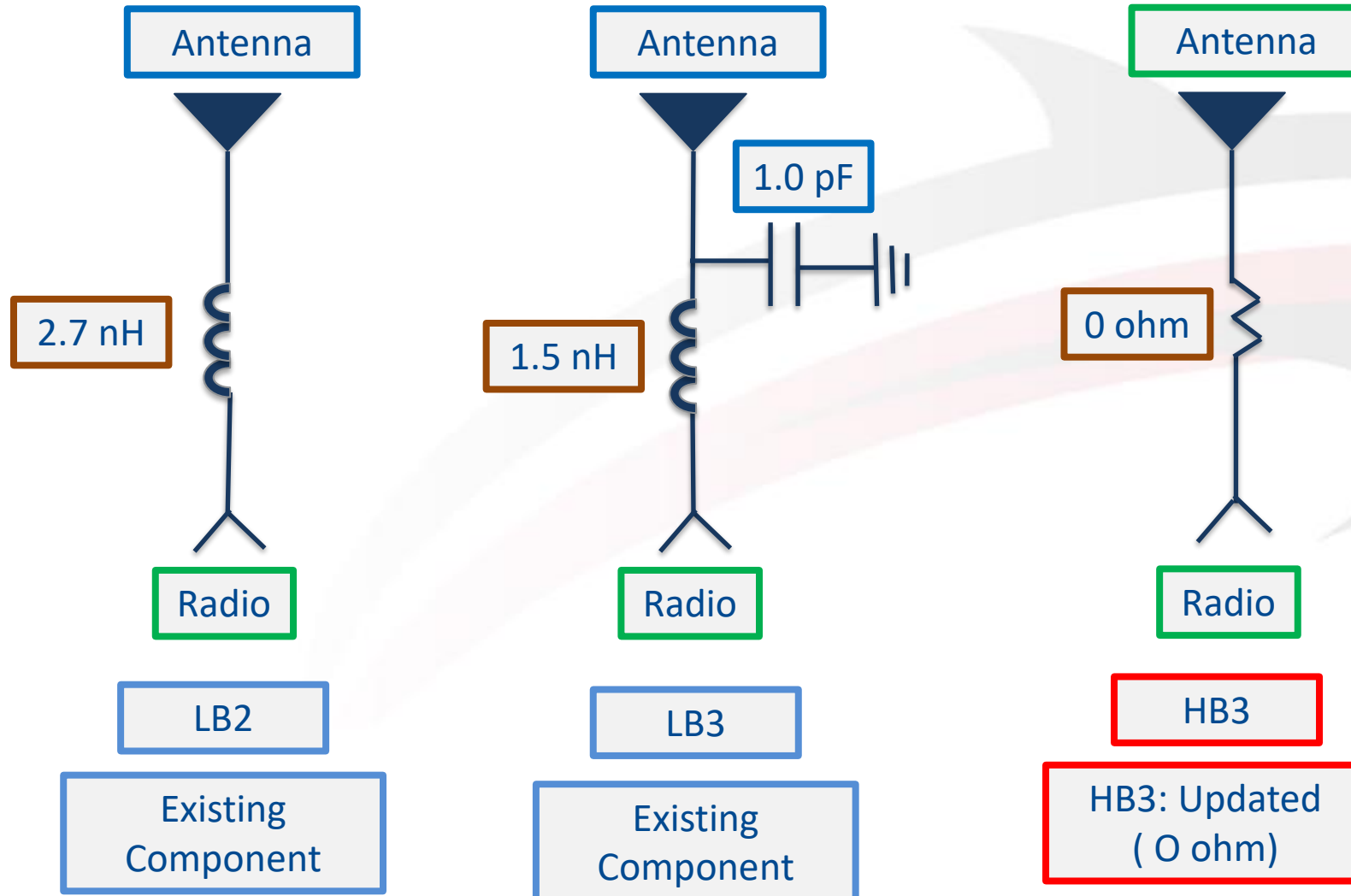


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LC Matching components

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Cable Length and Orientation

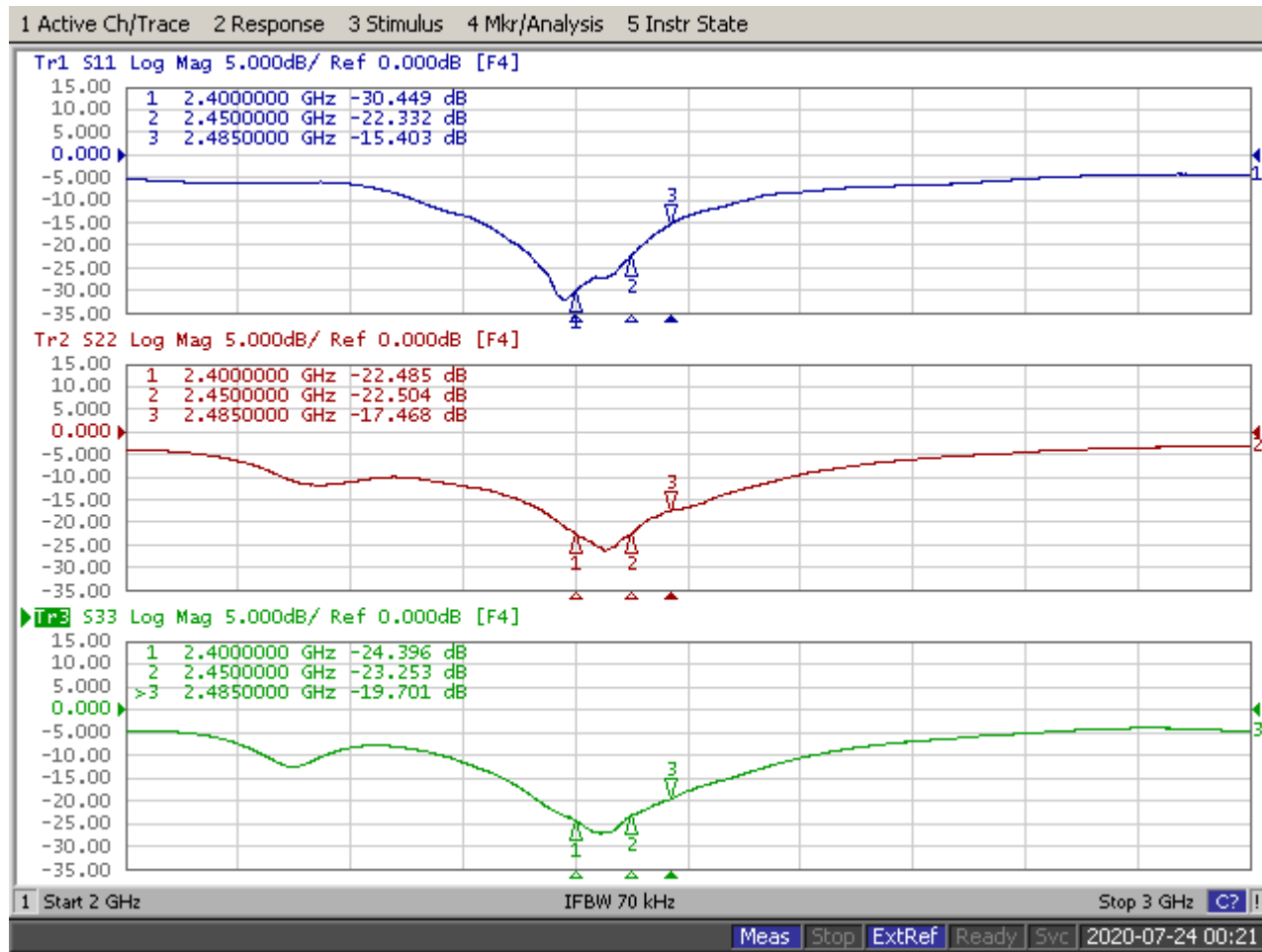


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Antenna	Cable Length	orientation	Cable Color
LB1_C	310 mm	H	Black
LB2	NA	Mix	NA
LB3	NA	V	NA
HB1	NA	V	NA
HB2	NA	H	NA
HB3	NA	H	NA
HB4_C	69 mm	V	Black

Antenna Return Loss of the Low Band

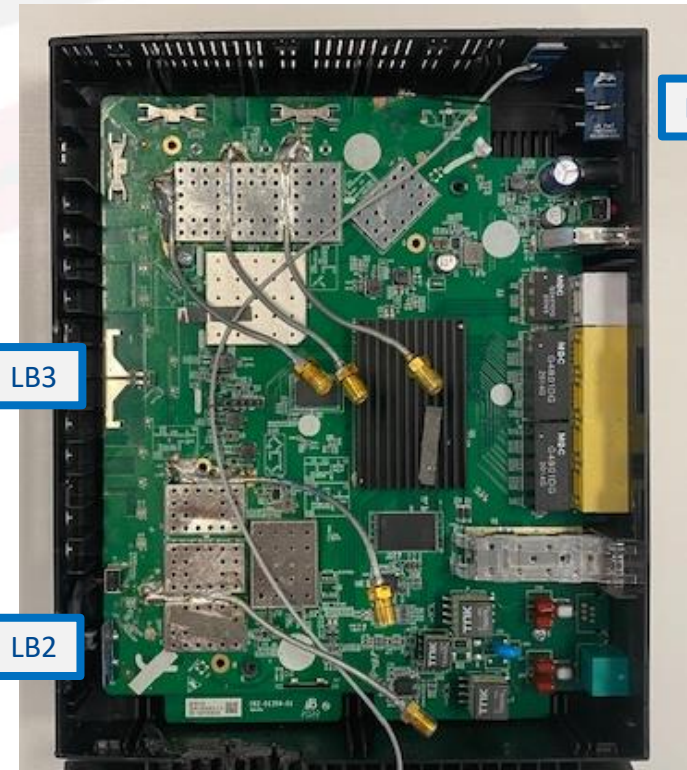
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Port 1= LB1_C

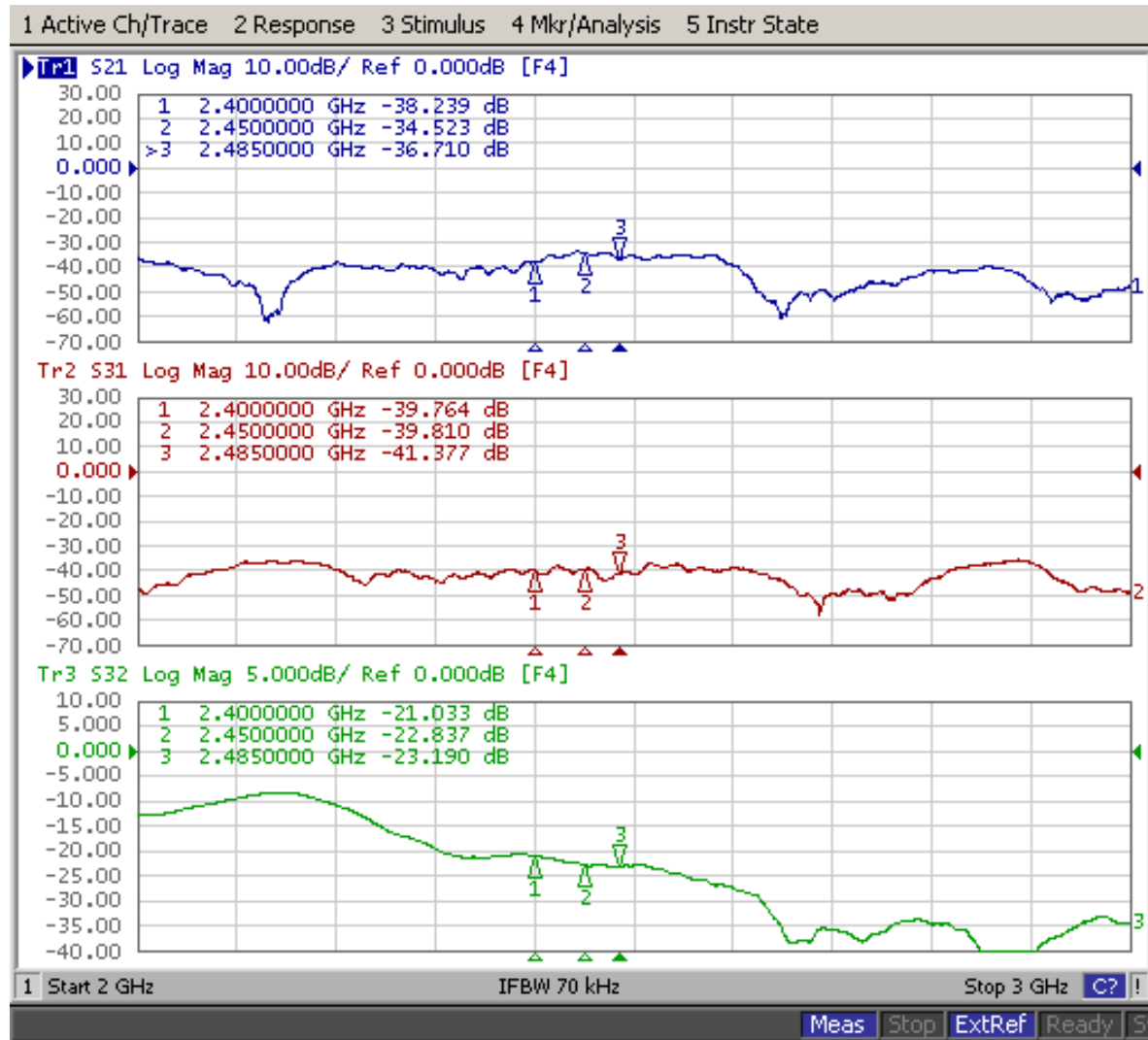
Port 2= LB2

Port 3= LB



Antenna Isolation of the Low Band

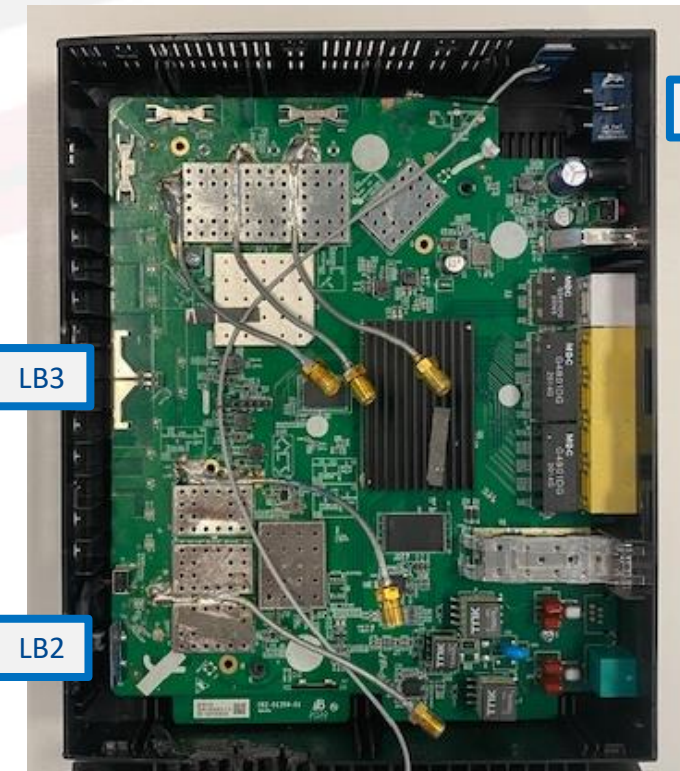
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Port 1= LB1_C

Port 2= LB2

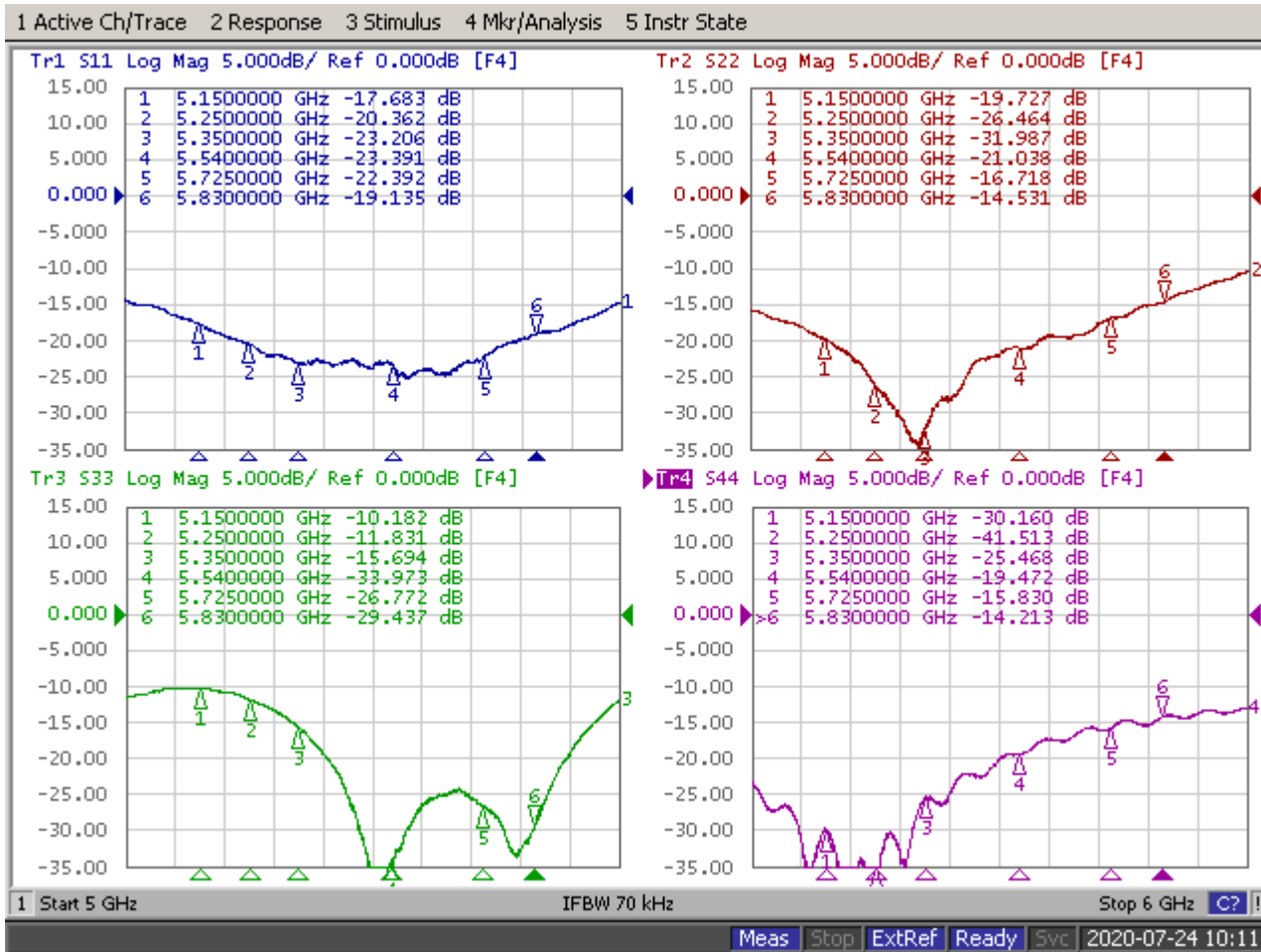
Port 3= LB



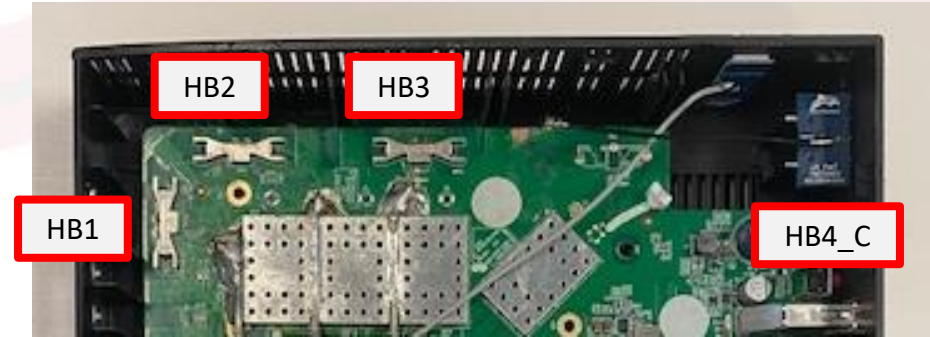
Antenna Return Loss of the High Band



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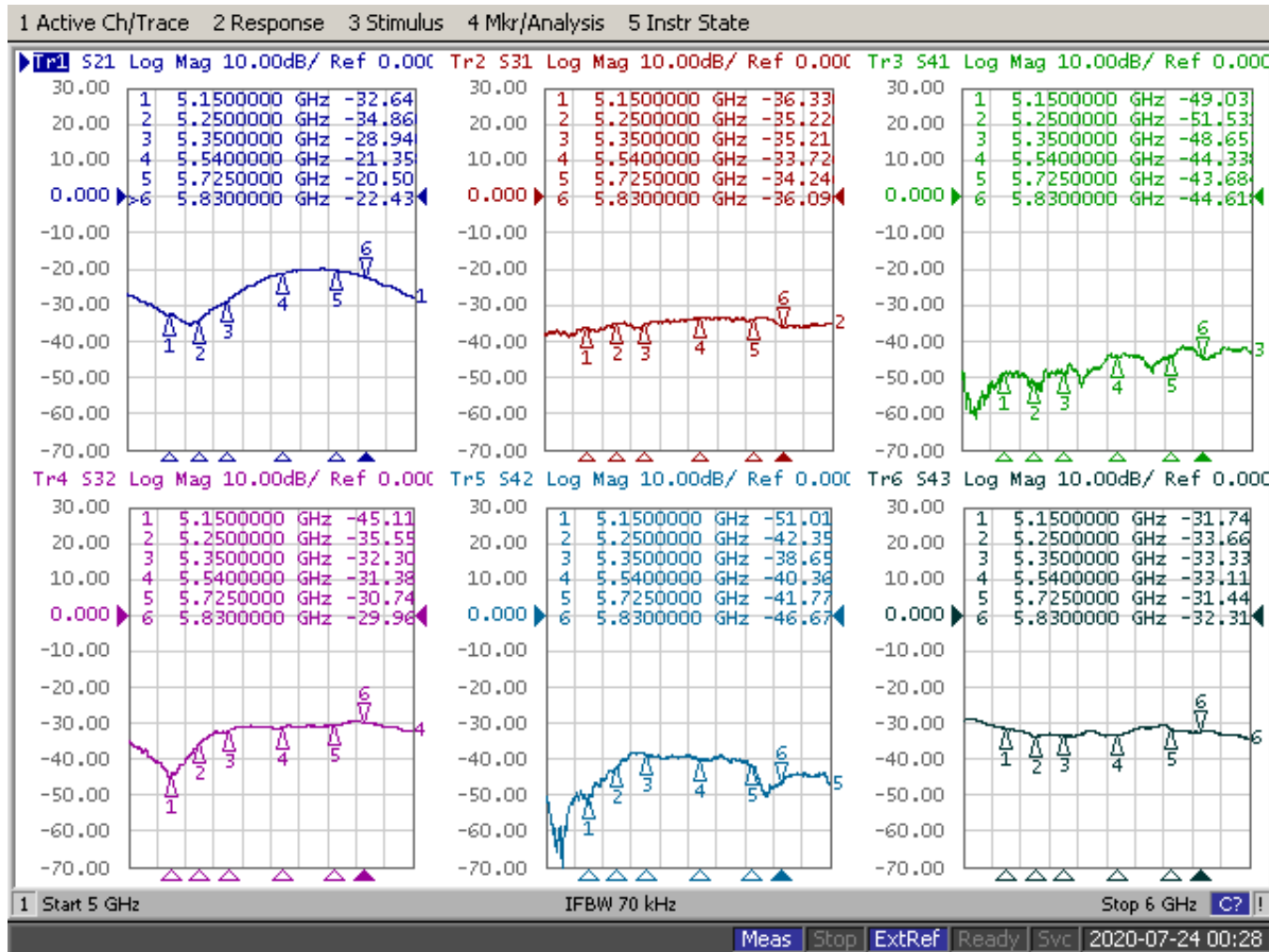
Port1= HB1	Port2= HB2
Port3= HB3	Port4= HB4_C



Antenna Isolation of the High Band



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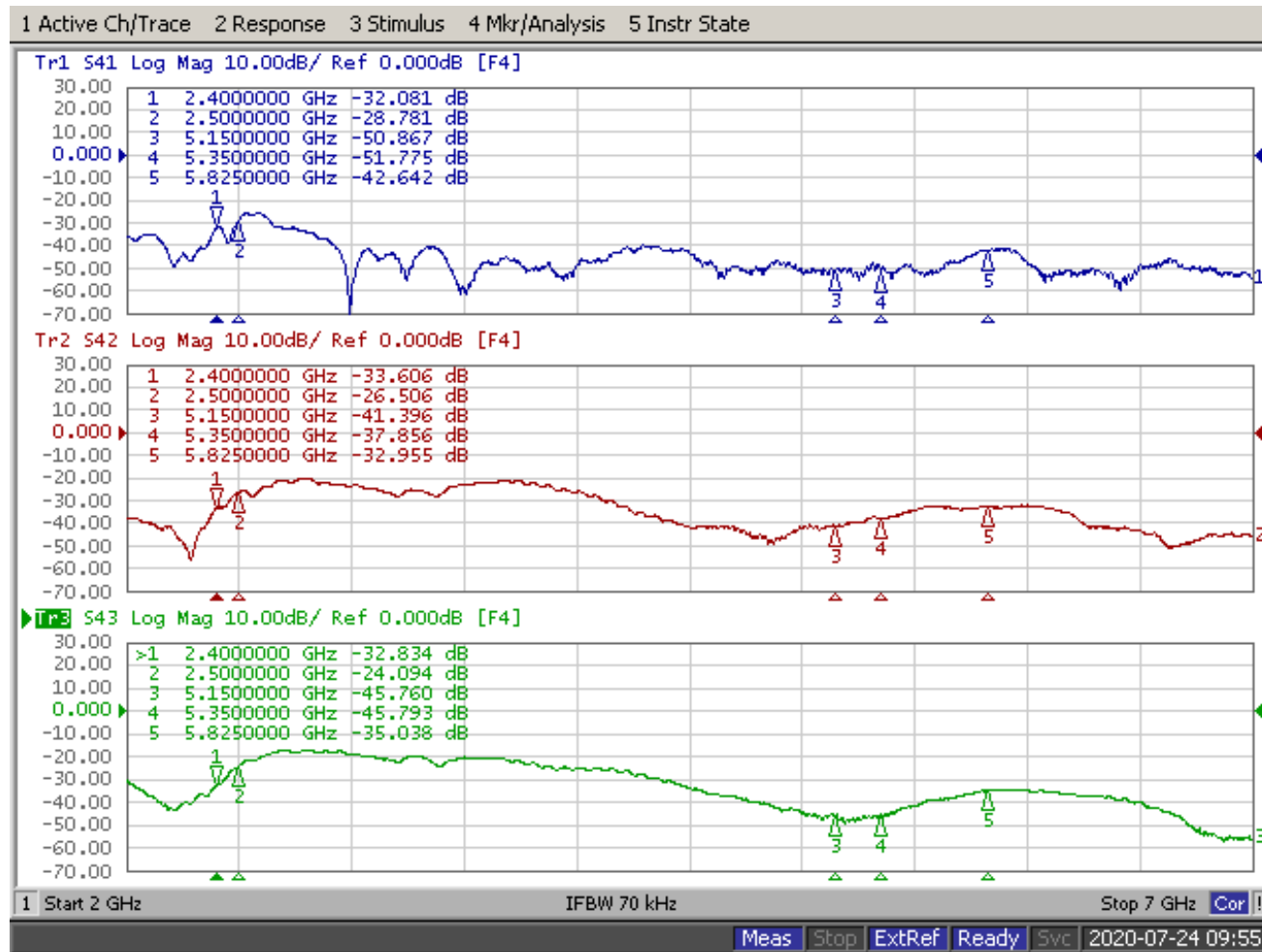


Port1= HB1	Port2= HB2
Port3= HB3	Port4= HB4_C

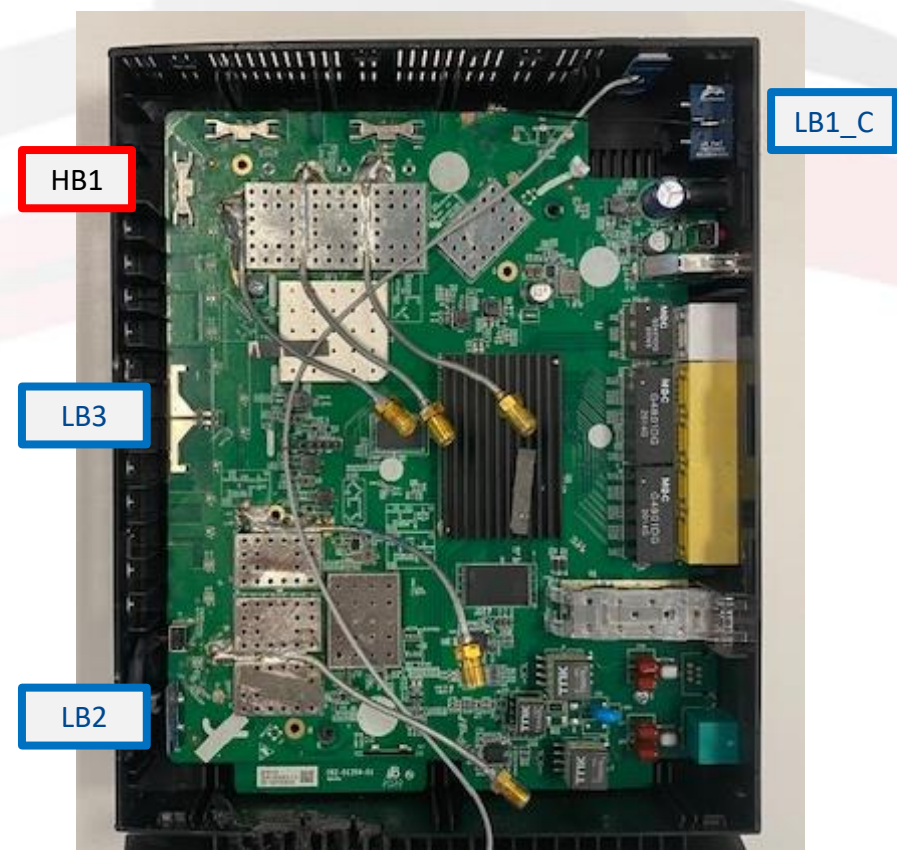


Antenna Isolation between LB and HB

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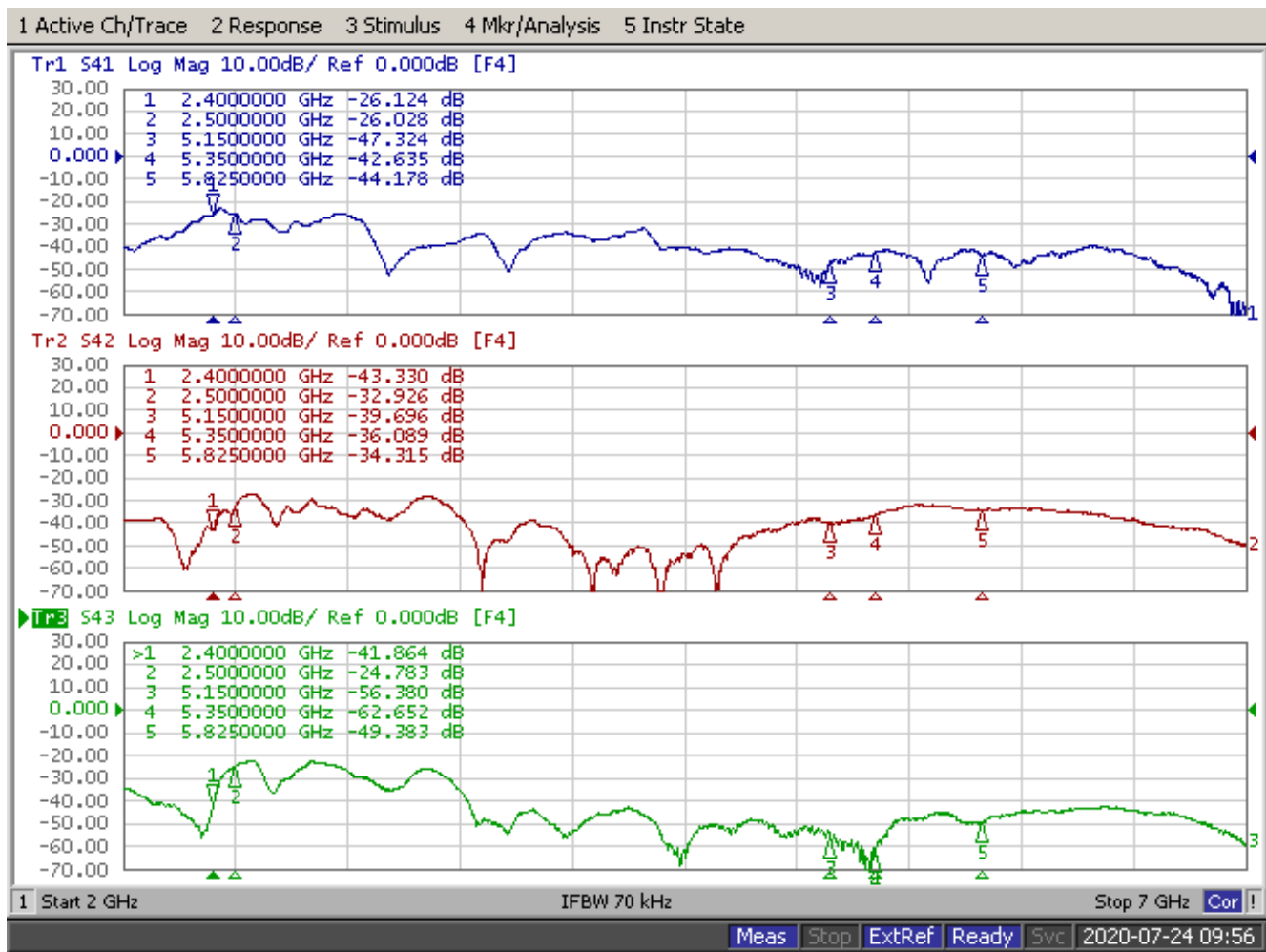
Port 1= LB1_C	Port 3= LB
Port 2= LB2	Port 4= HB1



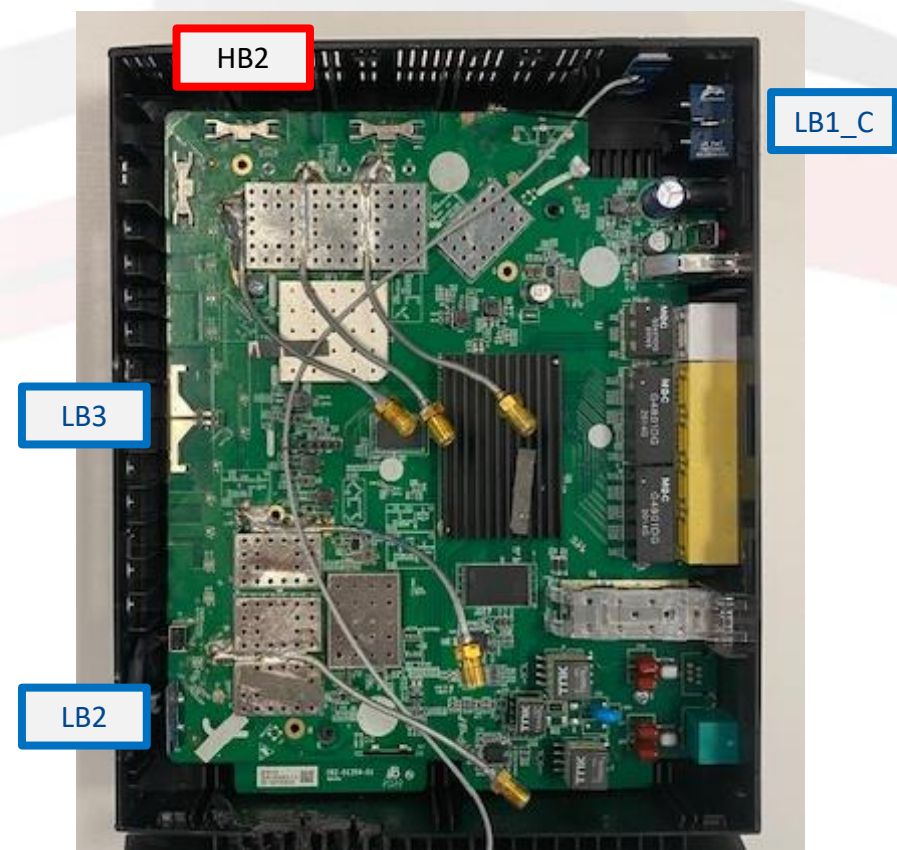
Antenna Isolation between LB and HB



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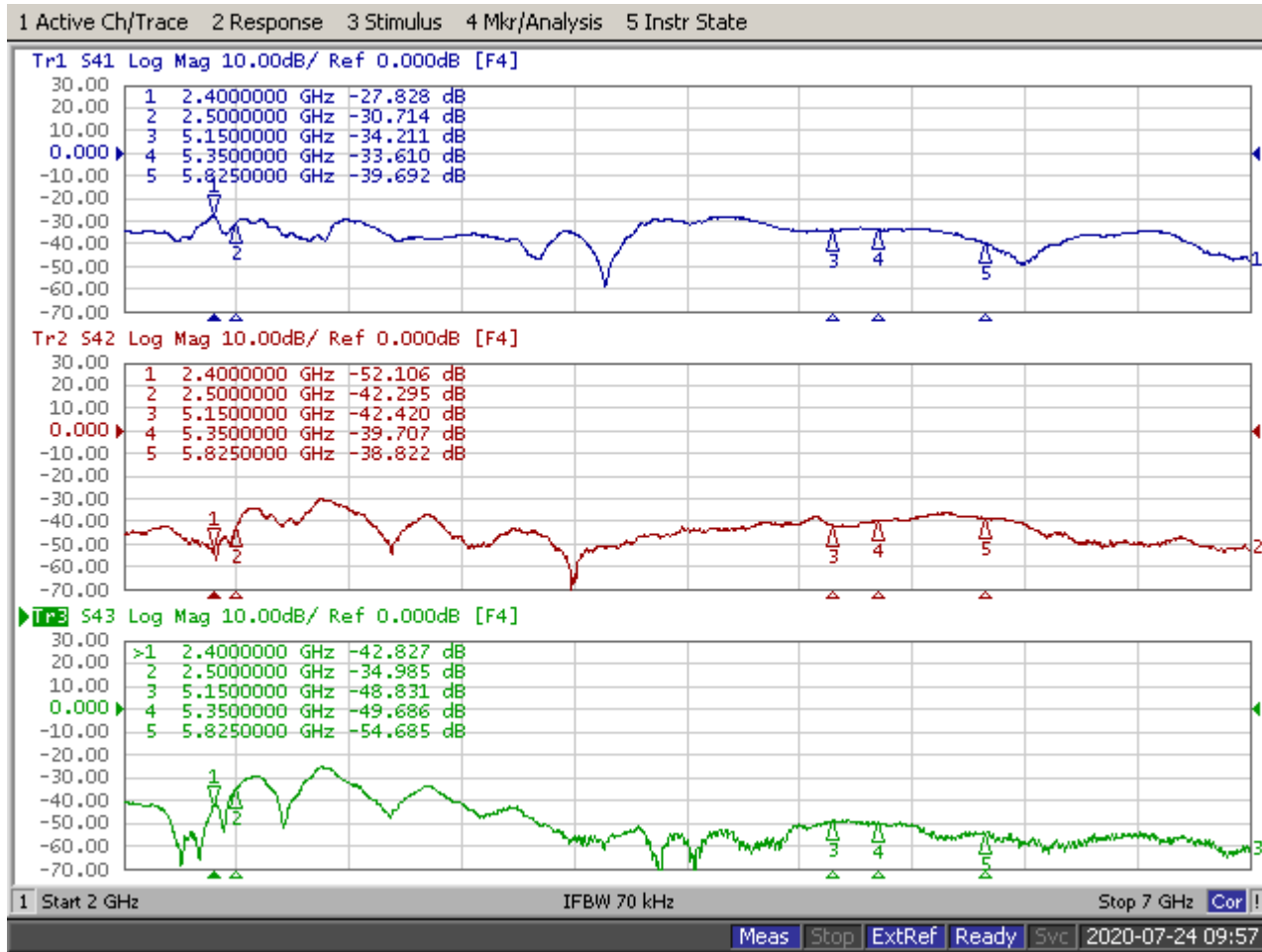
Port 1= LB1_C	Port 3= LB
Port 2= LB2	Port 4= HB2



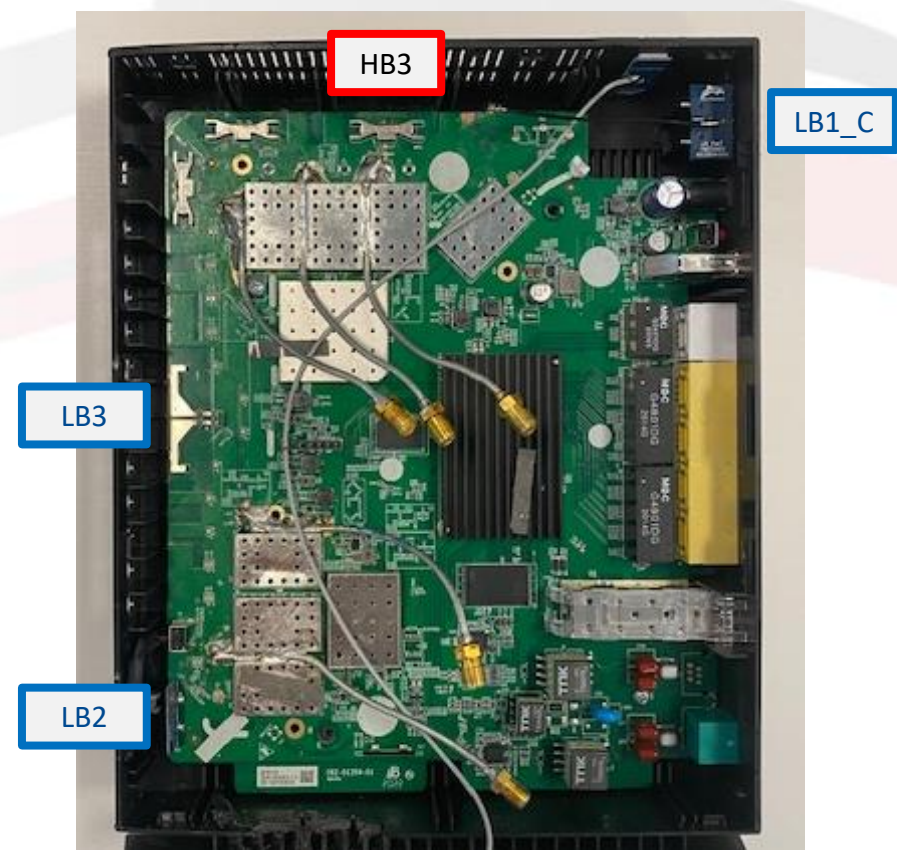
Antenna Isolation between LB and HB



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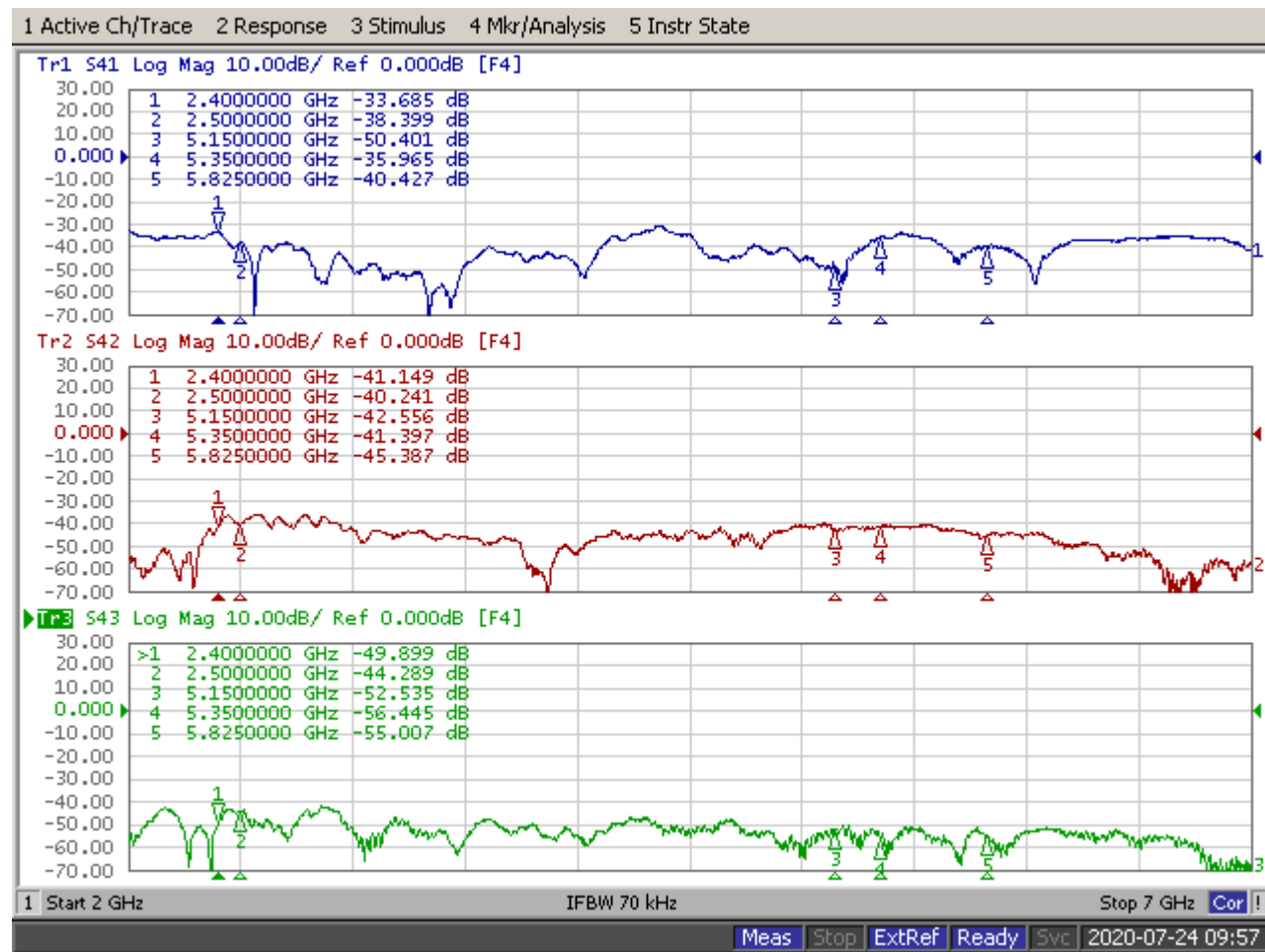


Port 1= LB1_C	Port 3= LB
Port 2= LB2	Port 4= HB3

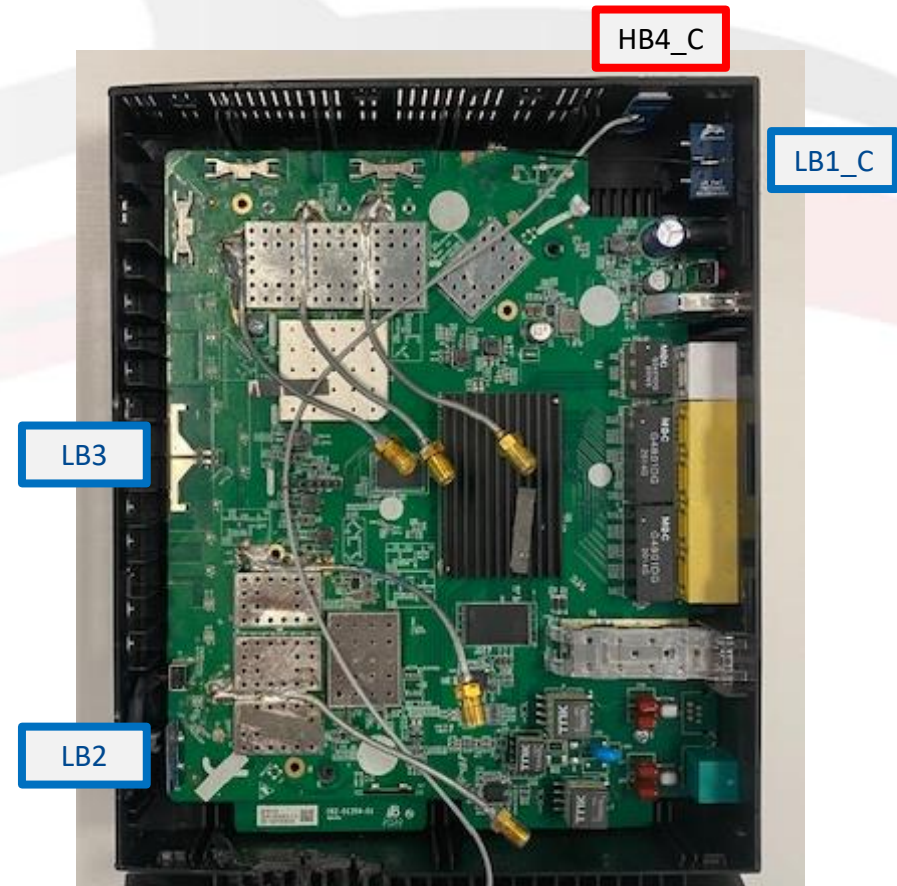


Antenna Isolation between LB and HB

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Port 1= LB1_C	Port 3= LB
Port 2= LB2	Port 4= HB4_C



Antenna with an enclosure

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Front



The antennas were tested in full in an enclosure



Z-direction¹⁵

Antennas Peak Gain and Efficiency



W E ' R E M A K I N G

LB 1_C	Freq (MHz)	Peak Gain (dBi)	Directivity (dB)	Efficiency
	2400	2.365	4.176	65.9 %
	2450	2.514	4.196	67.88 %
	2500	3.47	5.236	66.59 %
	Average			66.79 %

LB 2	Freq (MHz)	Peak Gain (dBi)	Directivity (dB)	Efficiency
	2400	3.885	5.209	73.73 %
	2450	4.358	5.545	76.08 %
	2500	4.911	5.907	79.51 %
	Average			76.44 %

LB 3	Freq (MHz)	Peak Gain (dBi)	Directivity (dB)	Efficiency
	2400	3.762	5.505	66.94 %
	2450	4.123	5.589	71.35 %
	2500	4.238	5.667	71.96 %
	Average			70.08 %

HB 1	Freq (MHz)	Peak Gain (dBi)	Directivity (dB)	Efficiency
	5150	3.624	5.271	68.43 %
	5250	4.246	5.602	73.17 %
	5350	4.707	6.347	68.55 %
	5725	4.21	5.997	66.26 %
	5825	2.861	4.973	61.48 %
	Average			67.58 %

HB 2	Freq (MHz)	Peak Gain (dBi)	Directivity (dB)	Efficiency
	5150	3.727	5.372	68.47 %
	5250	4.453	5.87	72.16 %
	5350	4.621	6.284	68.19 %
	5725	5.439	7.296	65.2 %
	5825	4.508	6.79	59.14 %
	Average			66.63 %

HB 3	Freq (MHz)	Peak Gain (dBi)	Directivity (dB)	Efficiency
	5150	4.435	6.358	64.23 %
	5250	4.211	5.869	68.27 %
	5350	4.328	5.889	69.82 %
	5725	4.612	5.745	77.04 %
	5825	4.595	5.927	73.59 %
	Average			70.59 %

HB 4_C	Freq (MHz)	Peak Gain (dBi)	Directivity (dB)	Efficiency
	5150	3.019	4.304	74.39 %
	5250	3.34	4.318	79.84 %
	5350	3.145	4.367	75.48 %
	5725	3.303	4.479	76.27 %
	5825	3.342	4.616	74.58 %
	Average			76.11 %

Formula of **Correlated & Uncorrelated** Gain

W E ' R E M A K I N G W A V E S TM

Correlated Gain(each angle) = $10 \log[(10^{G1/20} + 10^{G2/20} + \dots + 10^{GN/20})^2 / N_{ANT}]$ dBi

Uncorrelated Gain(each angle) = $10 \log[(10^{G1/10} + 10^{G2/10} + \dots + 10^{GN/10}) / N_{ANT}]$

dBi

Low Band Horizontal and Vertical Correlated directional Gain



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Frequency (MHz)	Degree		Gain (dBi)			Correlated Gain (dBi) - H-Pol
	Theta	Phi	LB1	LB2	LB3	
2400	117	150	0.58	-2.75	-9.87	1.75
2450	117	149	0.78	-2.33	-10.33	1.93
2500	117	145	0.64	-2.12	-10.12	1.97

Frequency (MHz)	Degree		Gain (dBi)			Correlated Gain (dBi)-V-Pol
	Theta	Phi	LB1	LB2	LB3	
2400	81	23	-9.17	2.55	3.61	5.34
2450	81	24	-10.56	2.76	3.77	5.37
2500	105	28	-11.12	3.90	3.93	5.90

Worst Case

Low Band Horizontal and Vertical UnCorrelated directional Gain



W E ' R E M A K I N G W A V E S ™

Frequency (MHz)	Degree		Gain (dBi)			UnCorrelated Gain (dBi) - H-Pol
	Theta	Phi	LB1	LB2	LB3	
2400	117	153	0.63	-2.74	-10.26	-2.26
2450	119	152	0.91	-2.39	-10.88	-2.01
2500	2	5	2.95	-14.54	-26.86	-1.74

Frequency (MHz)	Degree		Gain (dBi)			UnCorrelated Gain (dBi)-V-Pol
	Theta	Phi	LB1	LB2	LB3	
2400	83	23	-9.44	2.54	3.66	1.49
2450	106	30	-15.79	3.66	3.43	1.81
2500	109	31	-13.22	4.45	3.48	2.27

Worst Case

Horizontal and Vertical Correlated directional Gain



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Frequency (MHz)	Degree		Gain (dBi)				Correlated Gain (dBi) - H-Pol
	Theta	Phi	HB1	HB2	HB3	HB4_C	
5150	23	252	-0.46	-3.29	2.27	-17.85	3.69
5250	25	250	-0.44	-4.49	2.25	-13.52	3.67
5350	29	246	-1.20	-7.28	2.25	-11.03	3.17
5725	177	163	-5.03	-2.24	-1.82	-6.74	2.29
5825	95	159	1.22	-6.36	-1.25	-16.91	2.41

Frequency (MHz)	Degree		Gain (dBi)				Correlated Gain (dBi)-V-Pol
	Theta	Phi	HB1	HB2	HB3	HB4_C	
5150	47	12	3.15	3.41	-10.97	-5.08	5.48
5250	49	11	3.85	4.12	-10.43	-4.18	6.20
5350	52	12	4.49	4.31	-8.39	-4.16	6.69
5725	56	12	2.70	4.95	-5.31	-3.99	6.66
5825	54	22	-0.41	2.81	-4.73	-2.63	5.24

← Worst Case

Horizontal and Vertical UnCorrelated directional Gain



W E ' R E M A K I N G W A V E S ™

Frequency (MHz)	Degree		Gain (dBi)				UnCorrelated Gain (dBi) - H-Pol
	Theta	Phi	HB1	HB2	HB3	HB4_C	
5150	23	255	-0.55	-2.95	2.30	-19.97	-1.11
5250	26	253	-0.61	-4.29	2.38	-14.81	-1.24
5350	30	250	-1.47	-7.24	2.54	-12.57	-1.63
5725	108	125	2.68	-16.75	-1.97	-20.54	-2.01
5825	108	126	2.56	-10.44	-2.74	-19.97	-2.15

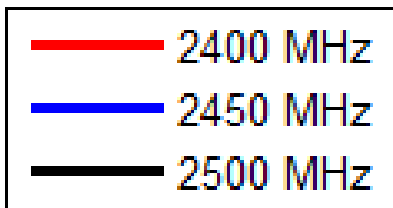
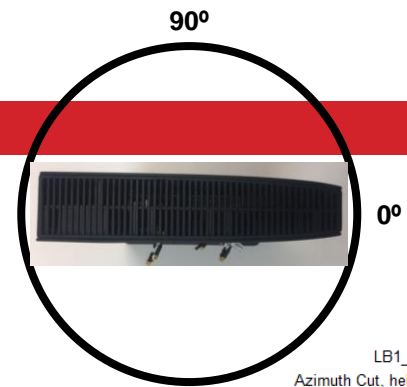
Frequency (MHz)	Degree		Gain (dBi)				UnCorrelated Gain (dBi)-V-Pol
	Theta	Phi	HB1	HB2	HB3	HB4_C	
5150	49	11	3.25	3.39	-11.90	-5.02	0.68
5250	49	10	3.88	4.12	-10.48	-4.27	1.37
5350	51	11	4.53	4.32	-8.52	-4.31	1.80
5725	55	11	2.83	4.92	-5.63	-3.96	1.54
5825	60	12	-1.21	3.85	-4.66	-4.86	-0.17

Worst Case

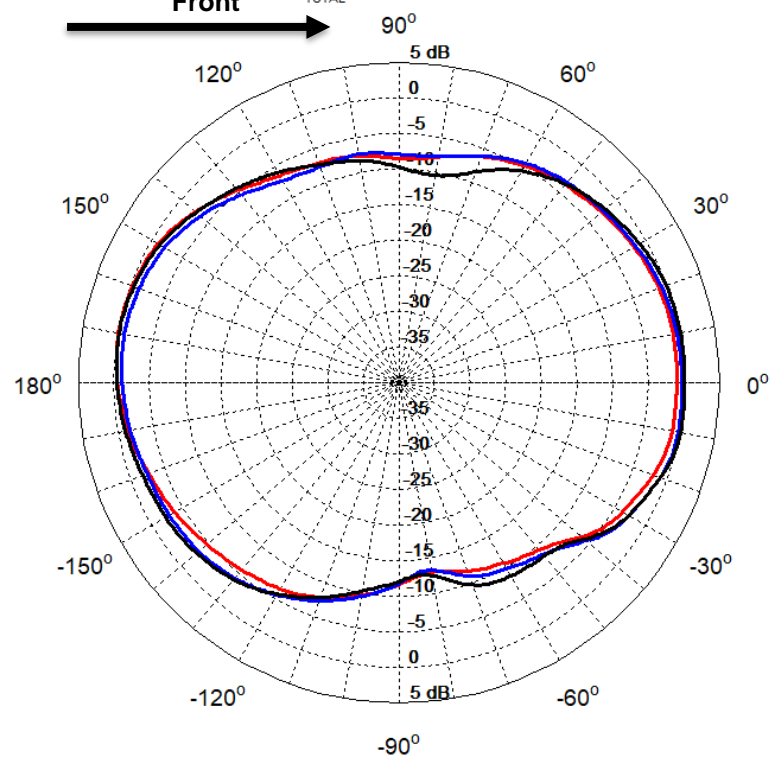
Azimuth Cut - Power Sum 2.45 GHz Band Antennas



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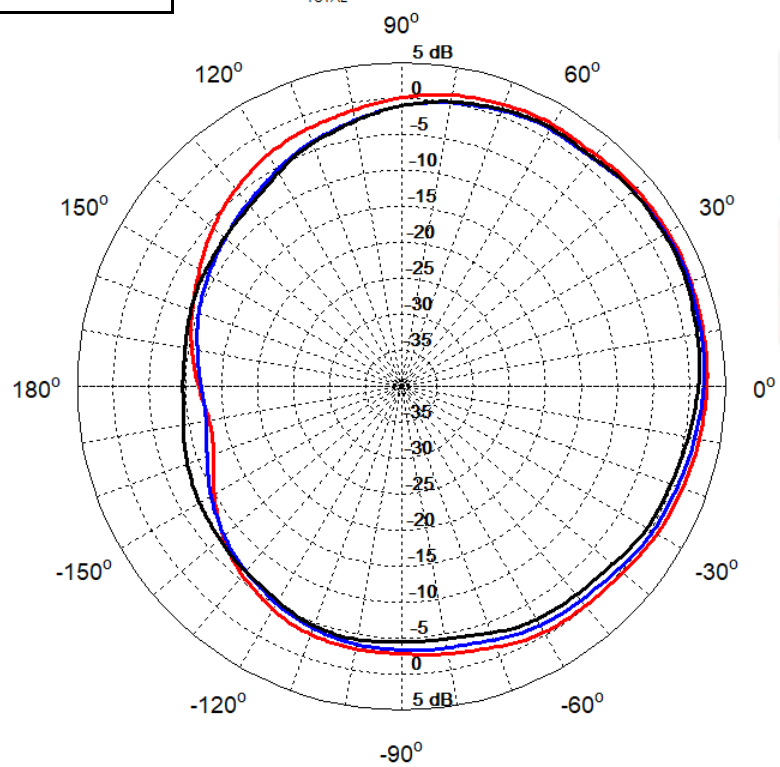


LB1_C
Azimuth Cut, held at $\theta = 90^\circ$.
 E_{TOTAL} (Power Σ) Component



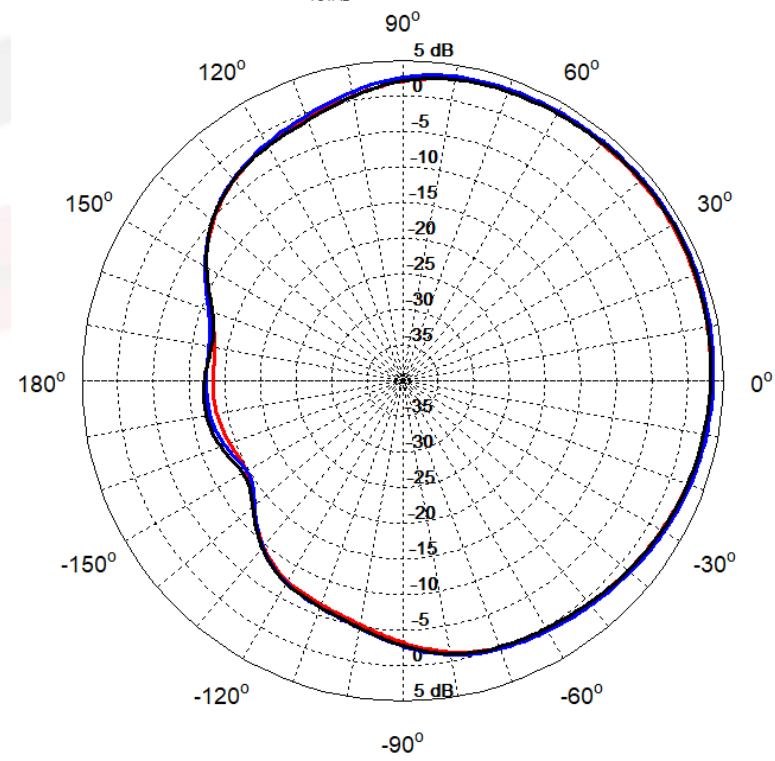
LB1_C

LB2
Azimuth Cut, held at $\theta = 90^\circ$.
 E_{TOTAL} (Power Σ) Component



LB2

LB3
Azimuth Cut, held at $\theta = 90^\circ$.
 E_{TOTAL} (Power Σ) Component

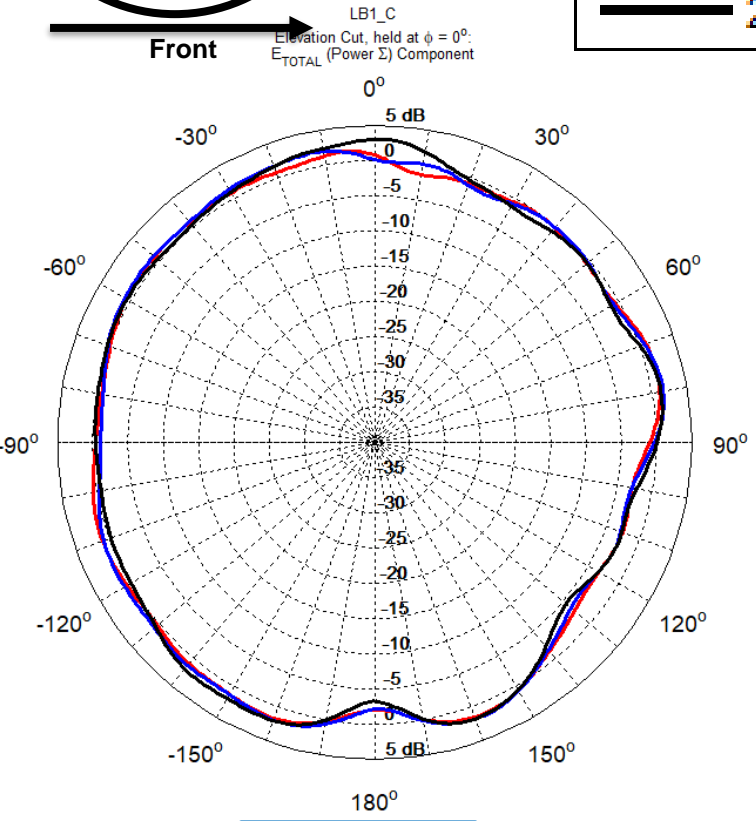
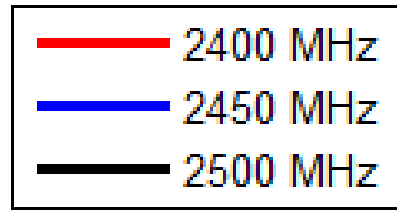
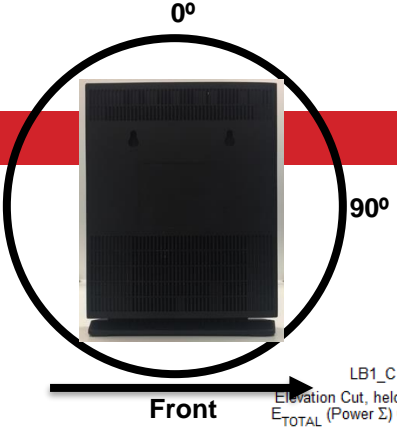


LB3

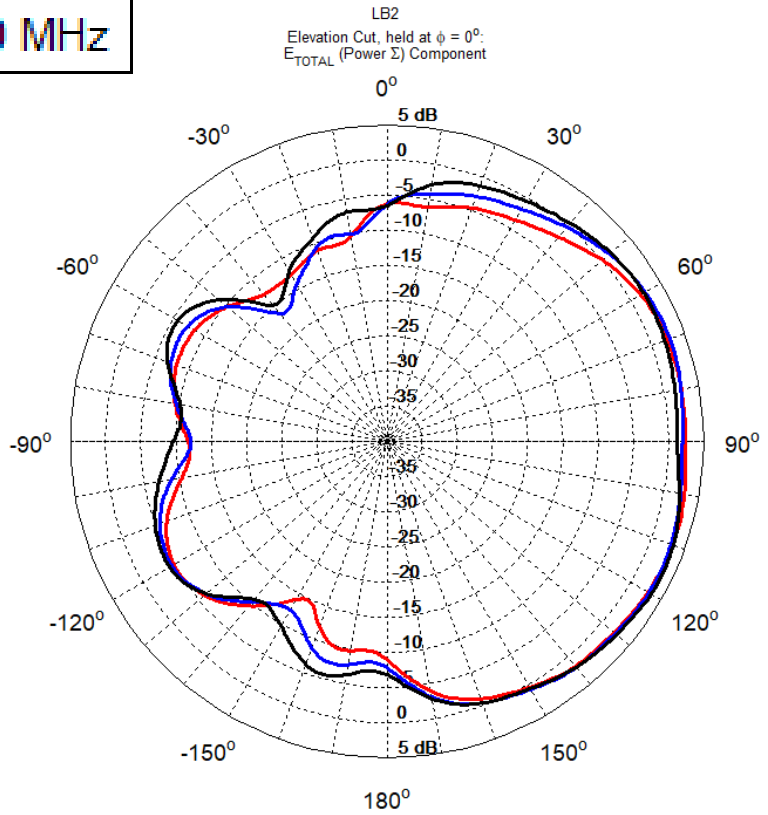
Elevation (Front to Back) Cut - Power Sum 2.45 GHz Band Antennas



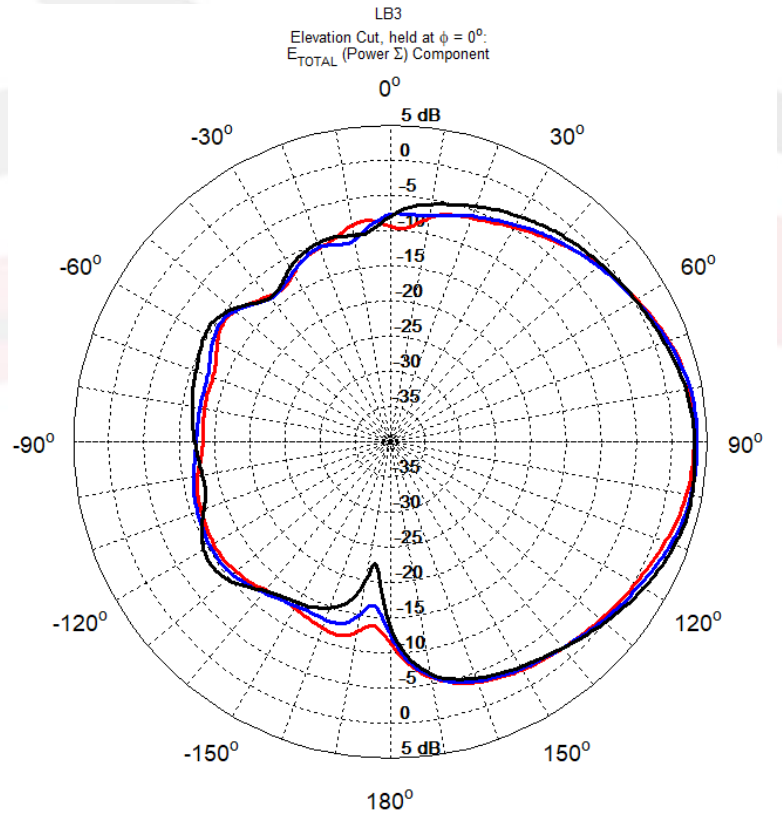
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LB1_C

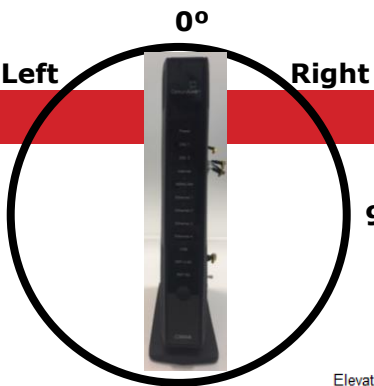


LB2

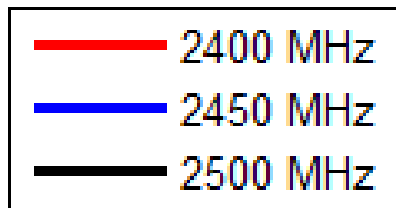


LB3

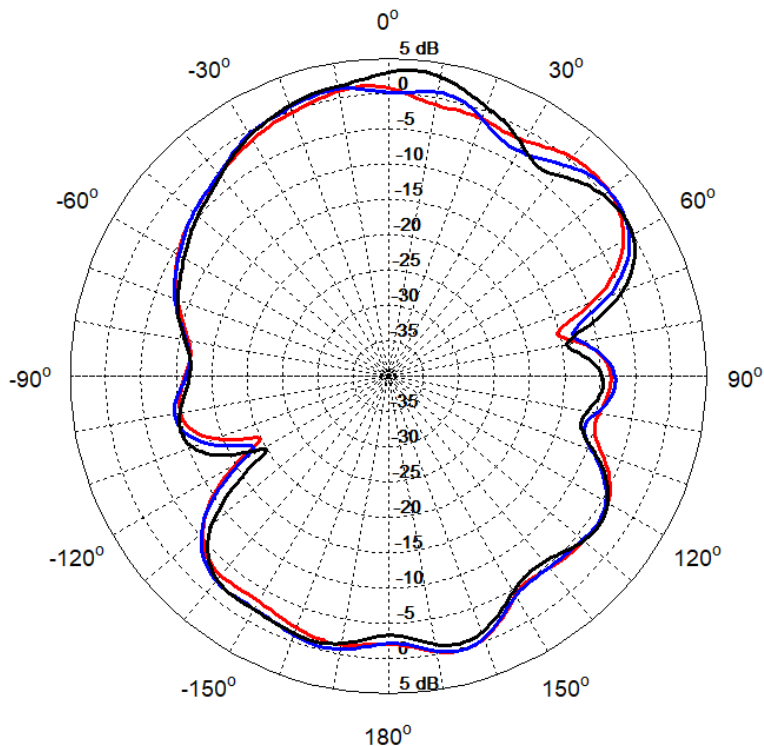
Elevation (Side to Side) Cut - Power Sum 2.45 GHz Band Antennas



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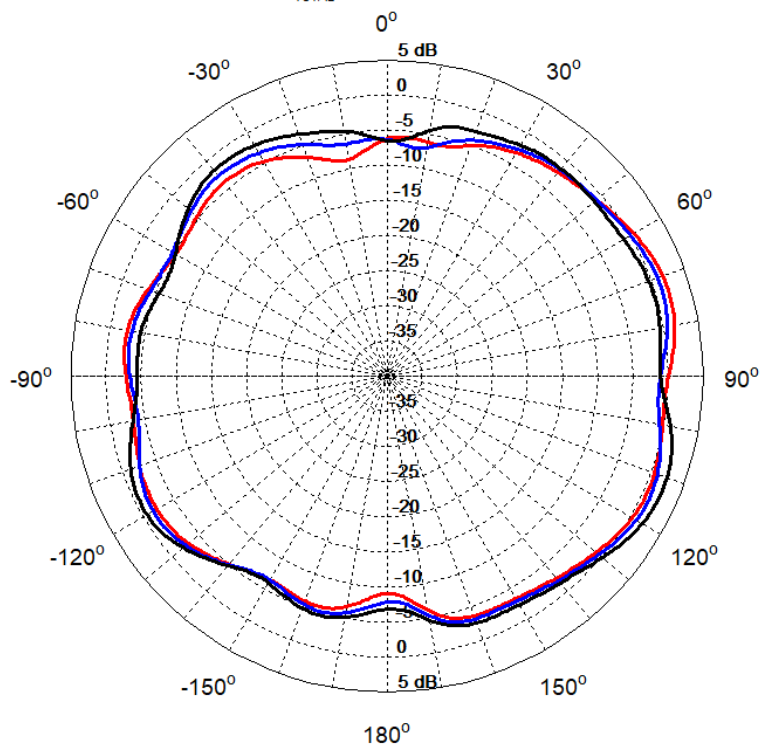


LB1_C
Elevation Cut, held at $\phi = 90^\circ$:
 E_{TOTAL} (Power Σ) Component



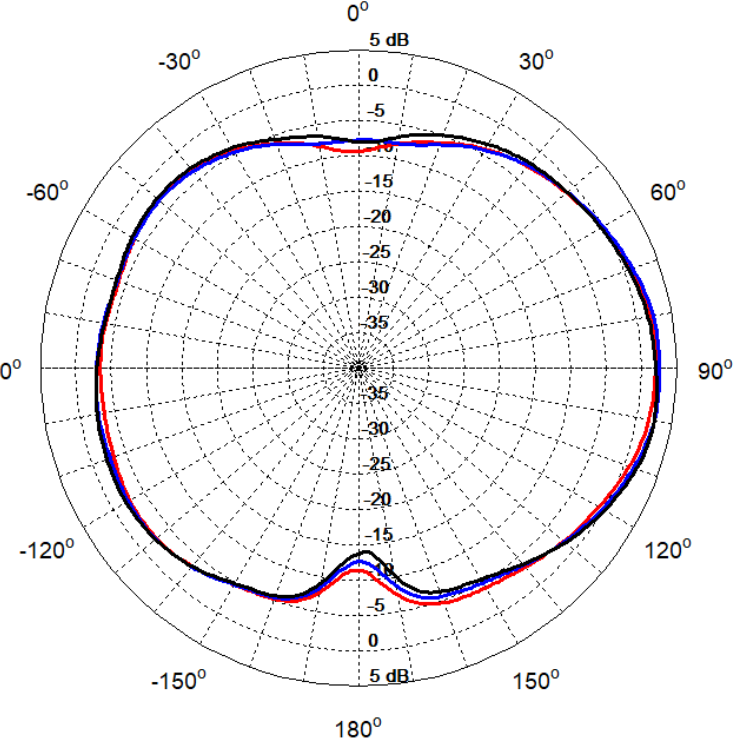
LB1_C

LB2
Elevation Cut, held at $\phi = 90^\circ$:
 E_{TOTAL} (Power Σ) Component



LB2

LB3
Elevation Cut, held at $\phi = 90^\circ$:
 E_{TOTAL} (Power Σ) Component

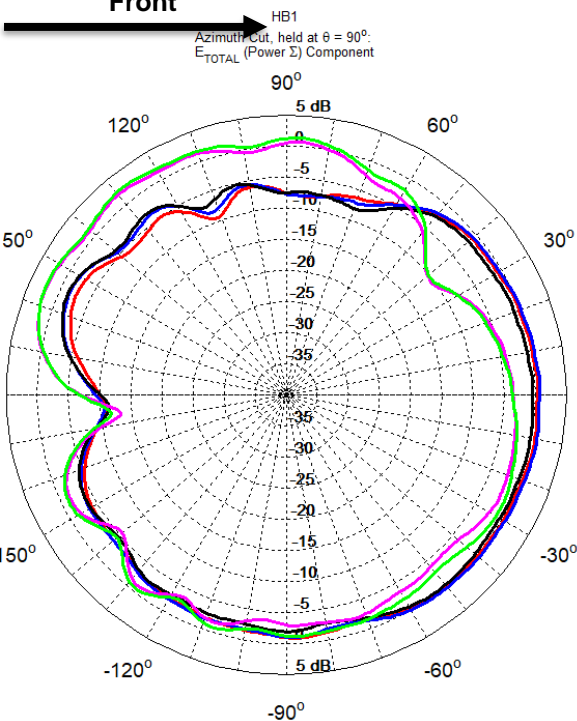
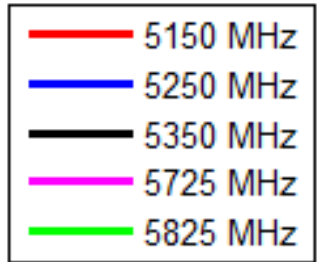
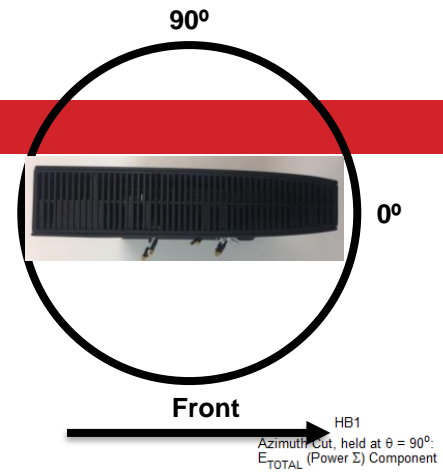


LB3

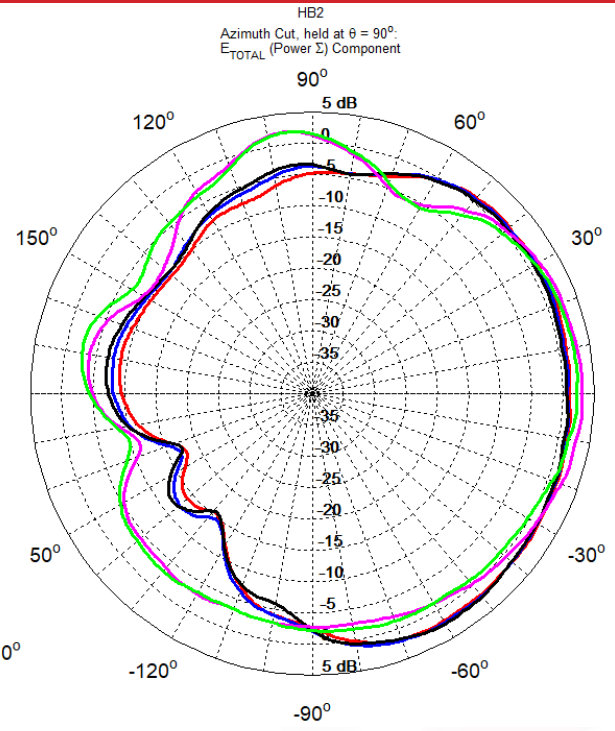
Azimuth Cut - Power Sum 5 GHz Antennas



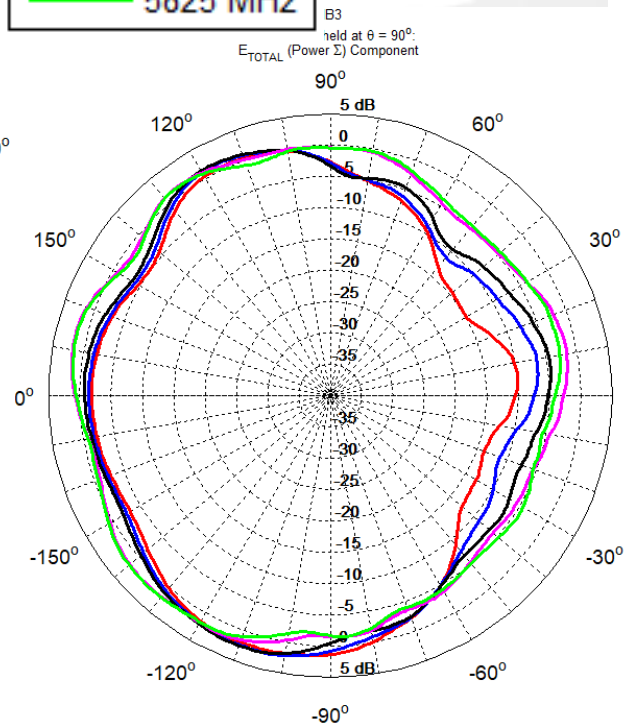
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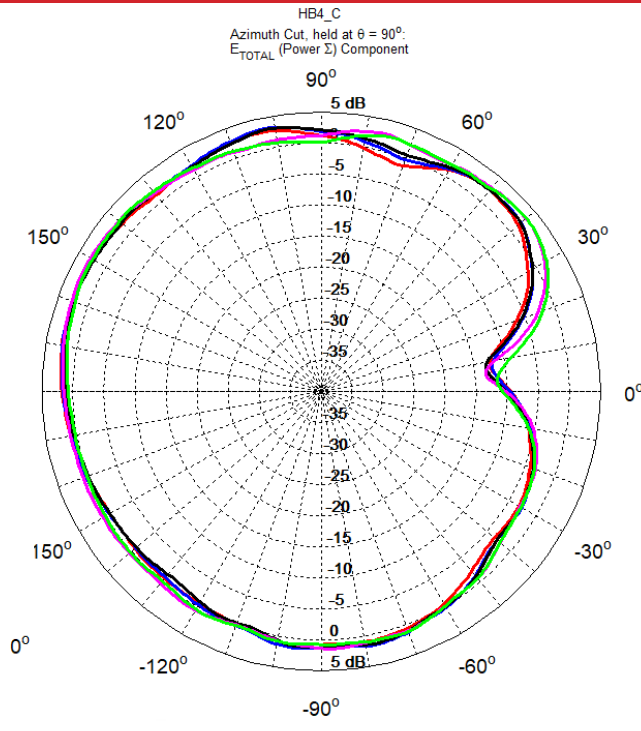
HB1



HB2



HB3

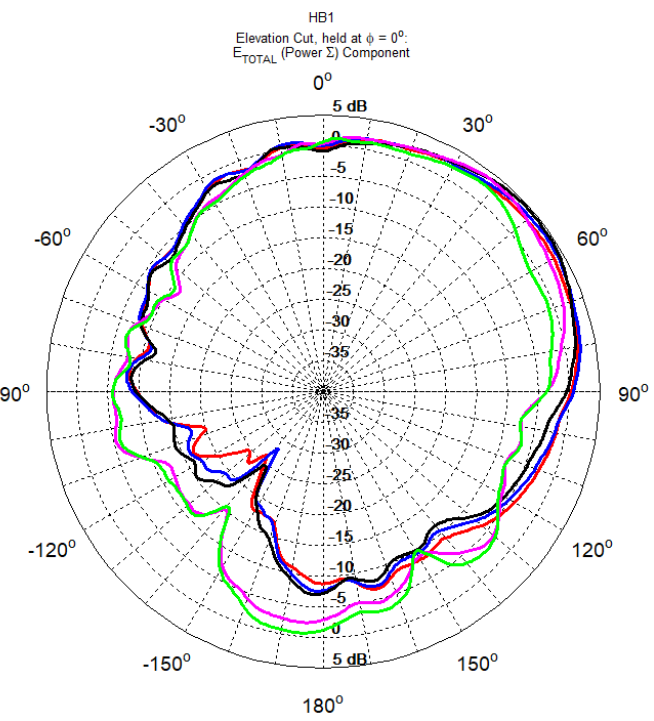
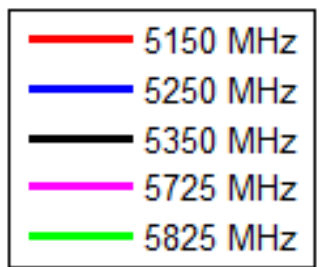
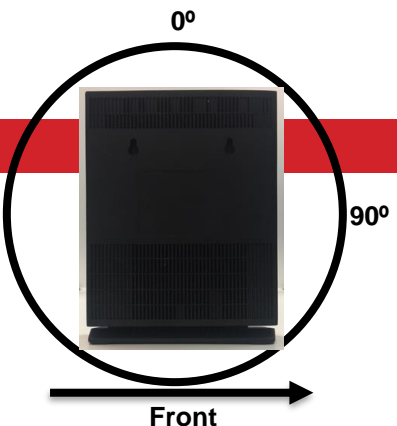


HB4

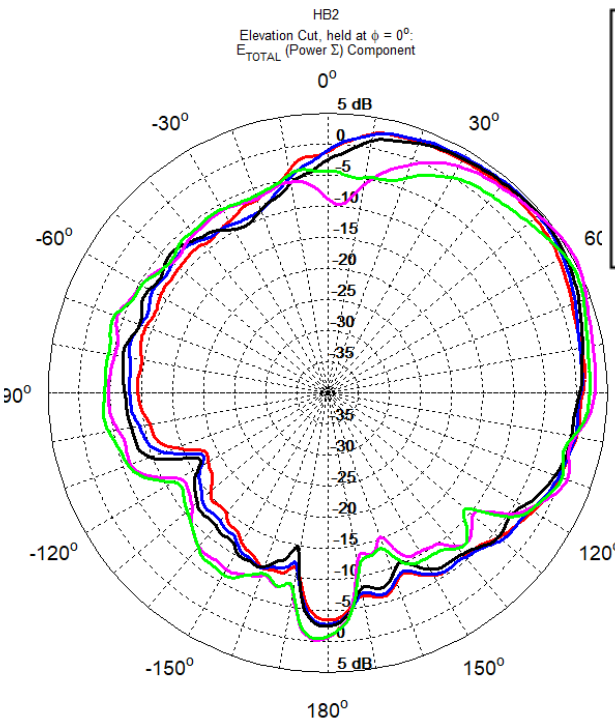
Elevation (Front to Back) Cut - Power Sum 5 GHz Antennas



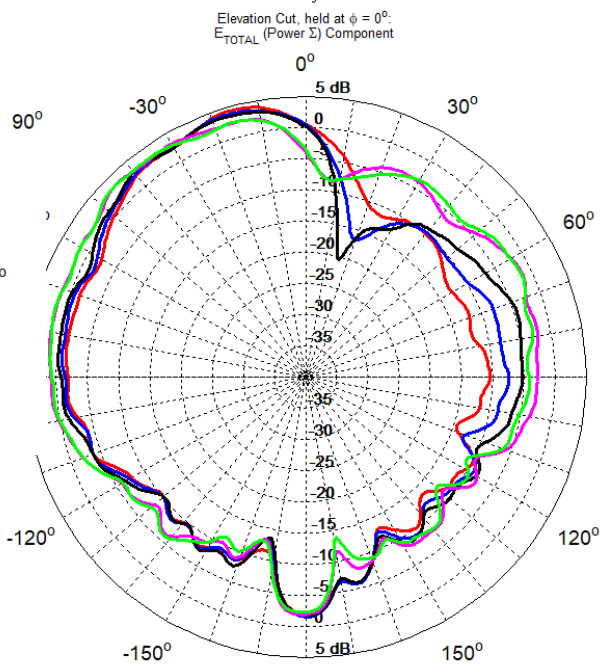
WE'RE MAKING WAVES™



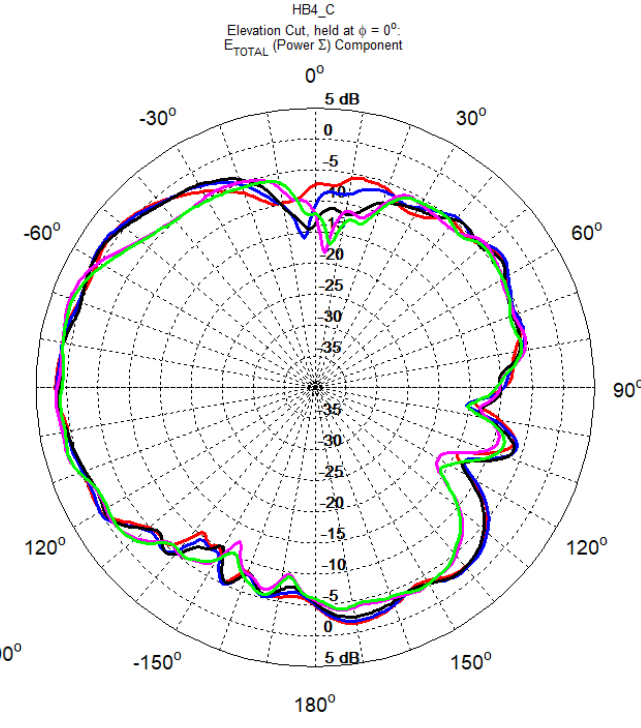
HB1



HB2

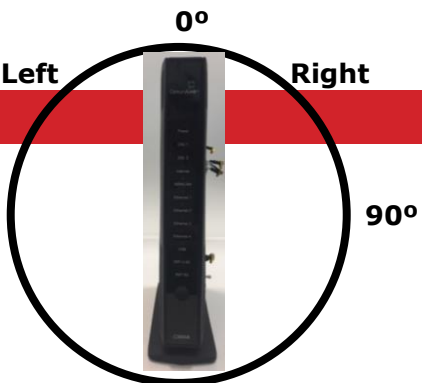


HB3

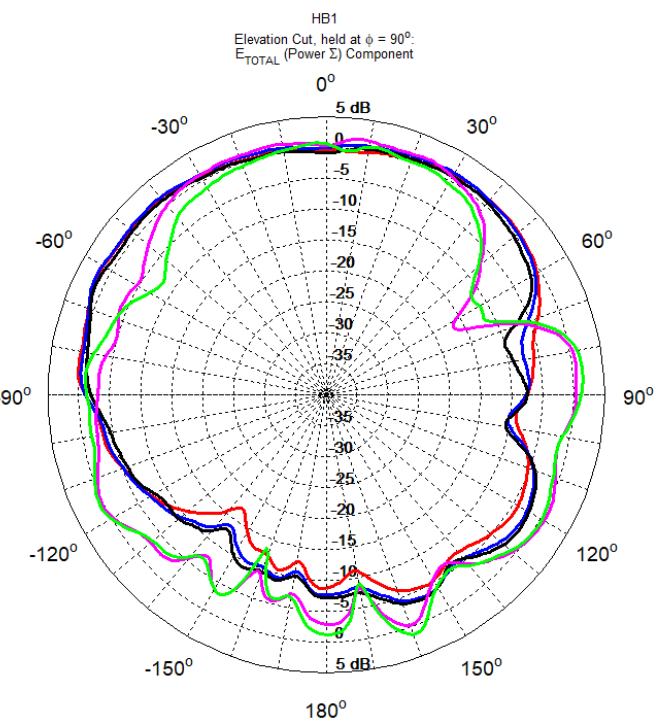
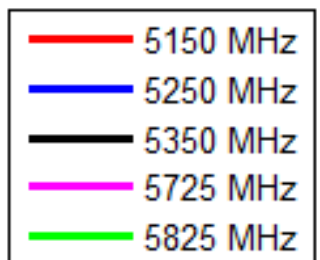


HB4

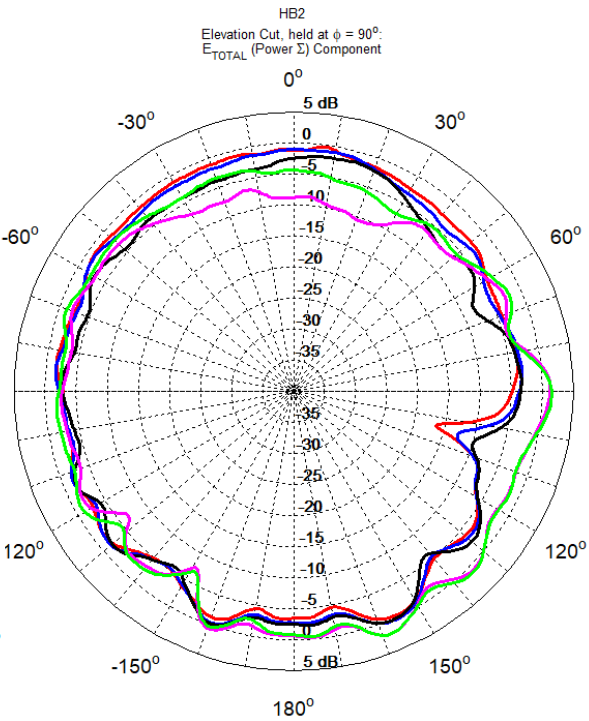
Elevation (Side to Side) Cut - Power Sum 5 GHz Antennas



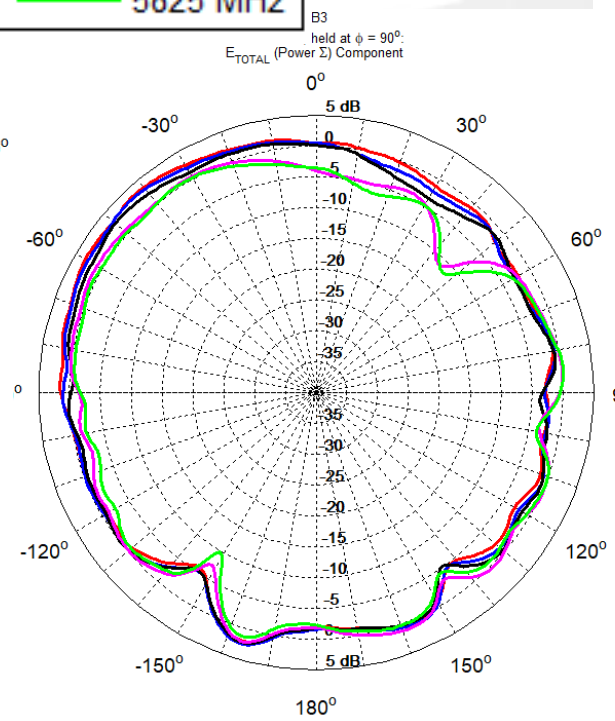
WE'RE MAKING WAVES™



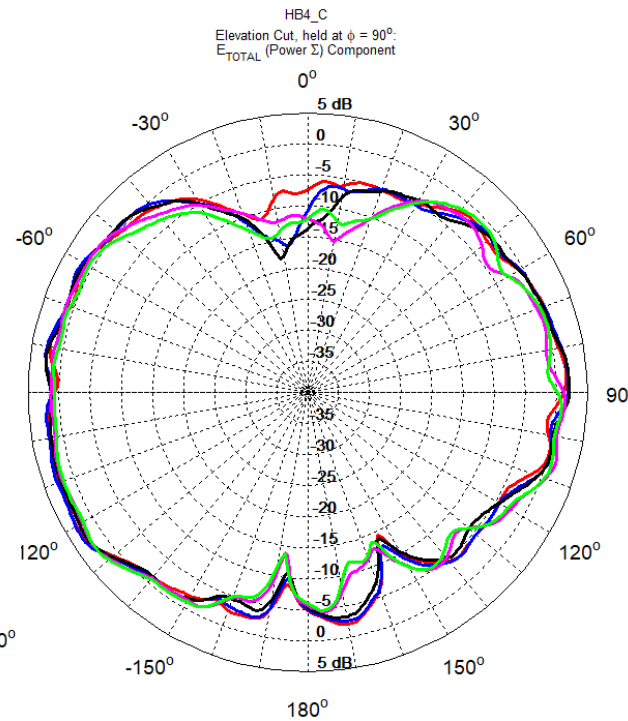
HB1



HB2



HB3

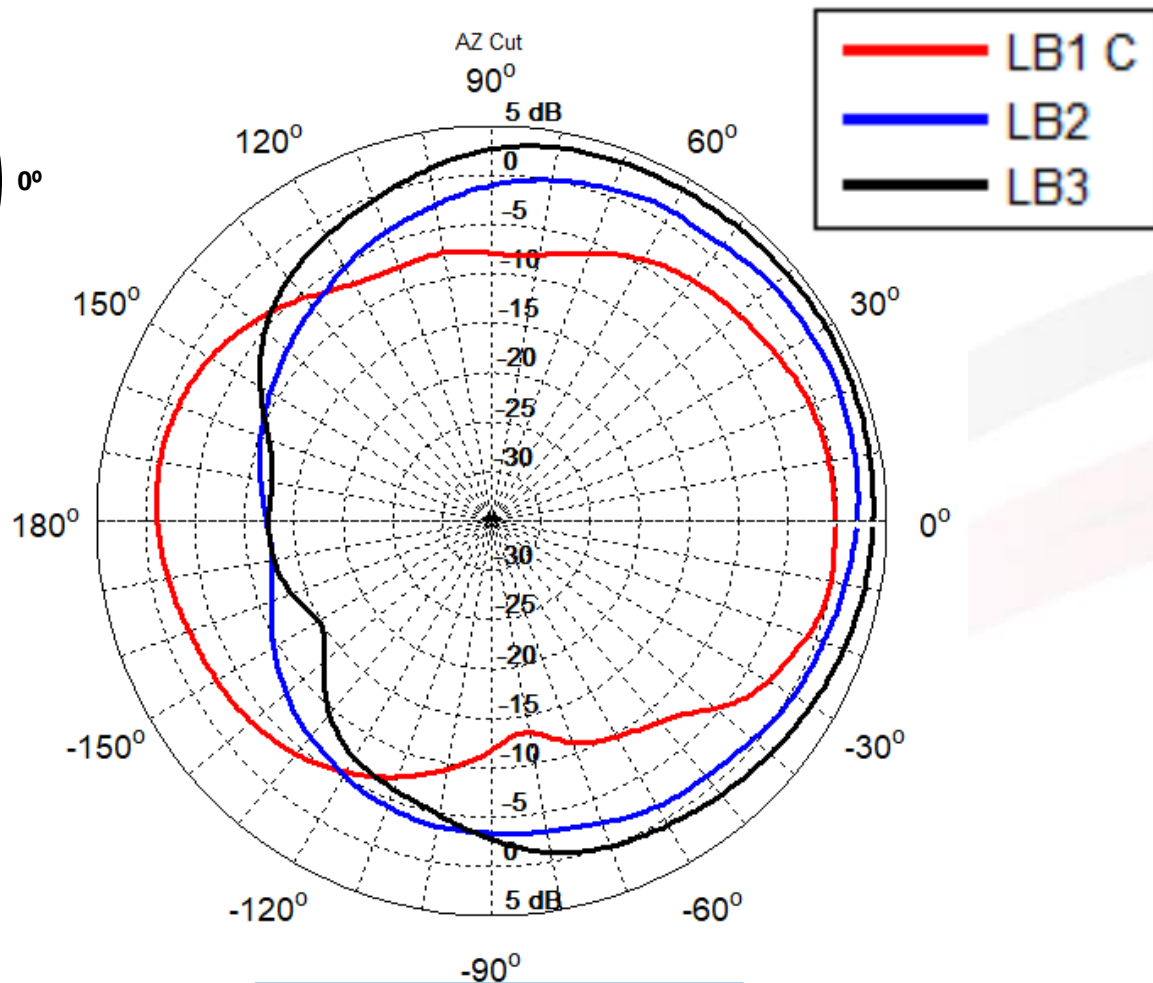
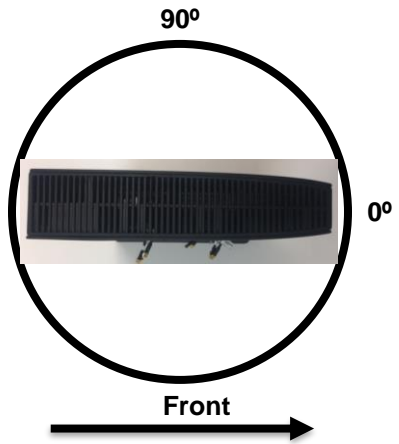


HB4

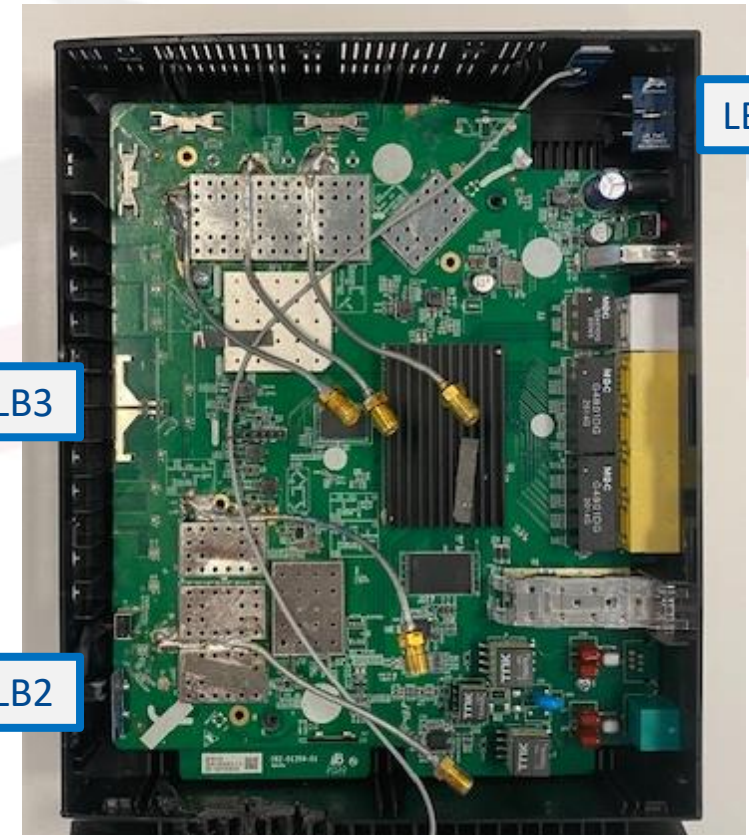
Azimuth Cut - Power Sum System Coverage – Low Band



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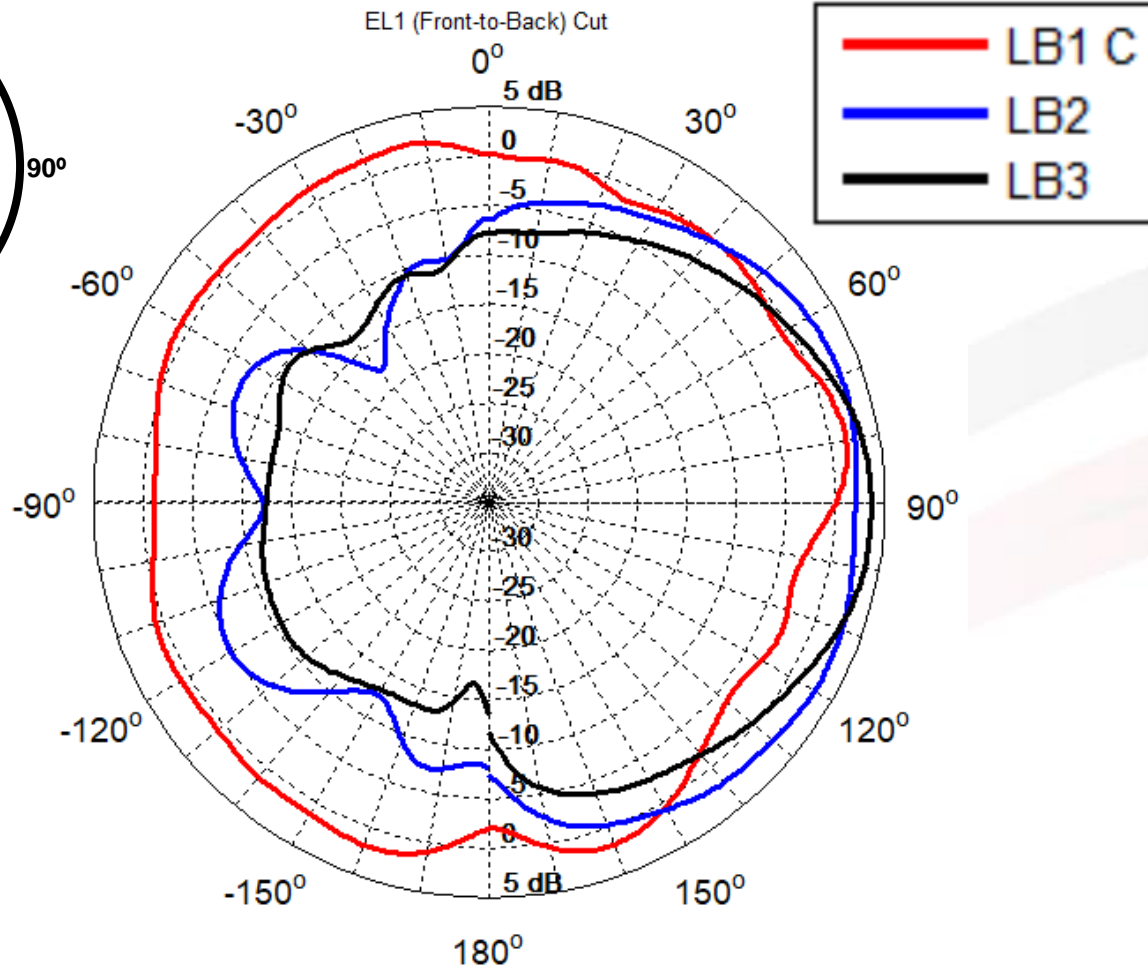
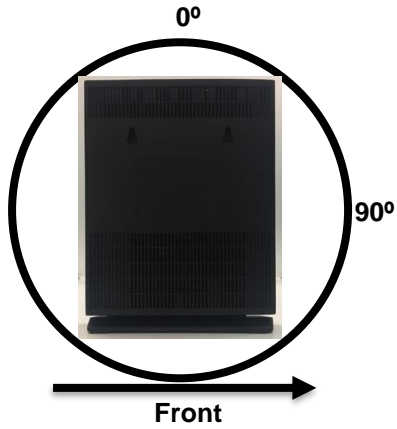
Low Band – 2.45 GHz



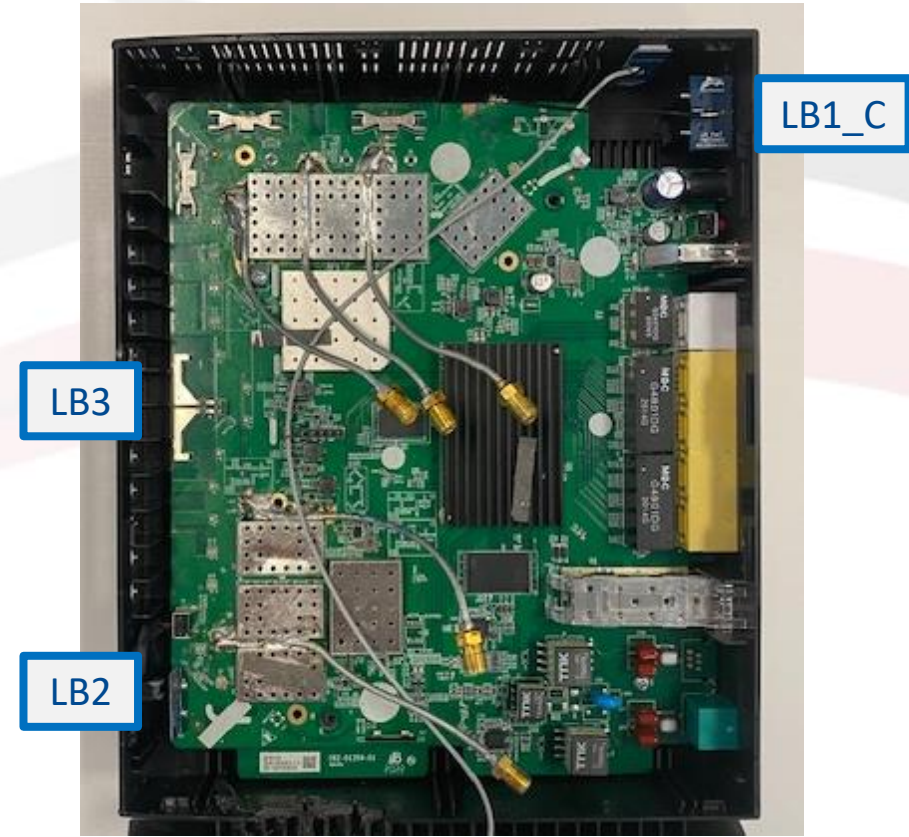
Elevation (Front to Back) Cut - Power Sum System Coverage – Low Band



WE'RE MAKING WAVES™



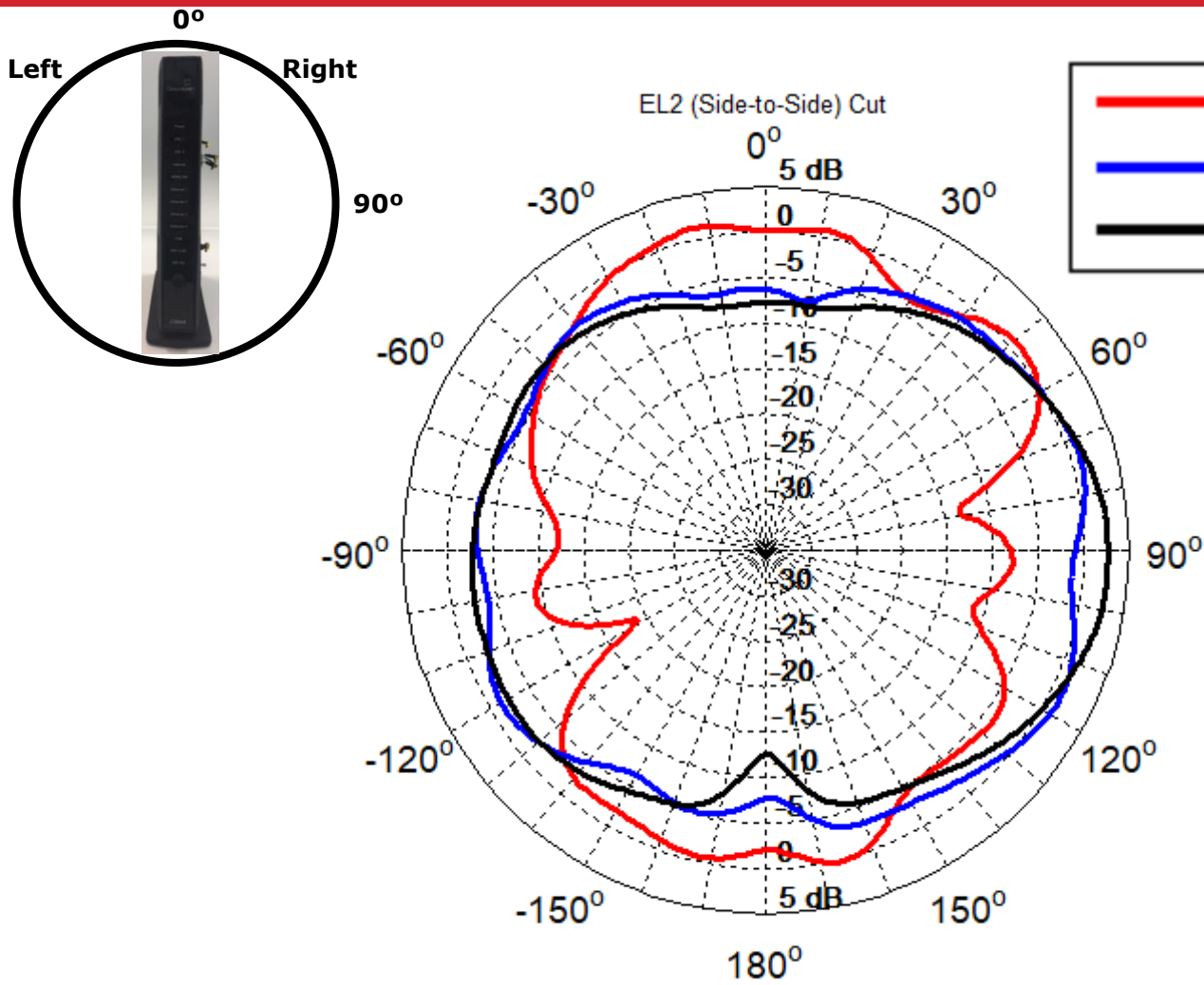
Low Band – 2.45 GHz



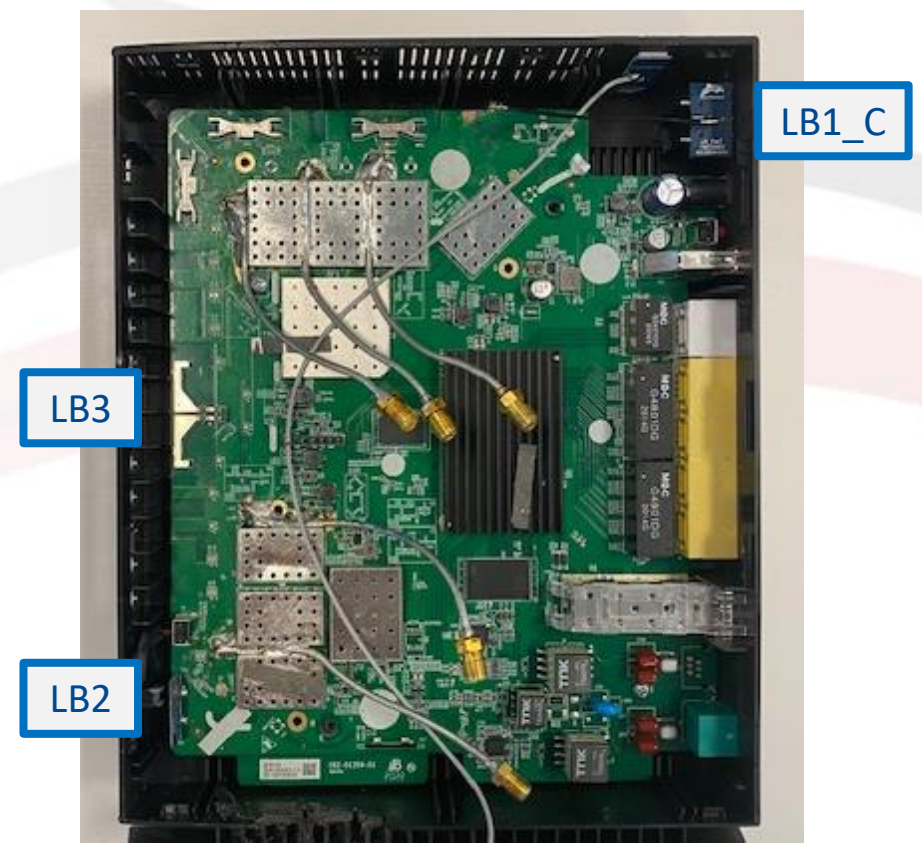
Elevation (Side to Side) Cut - Power Sum System Coverage – Low Band



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Low Band – 2.45 GHz

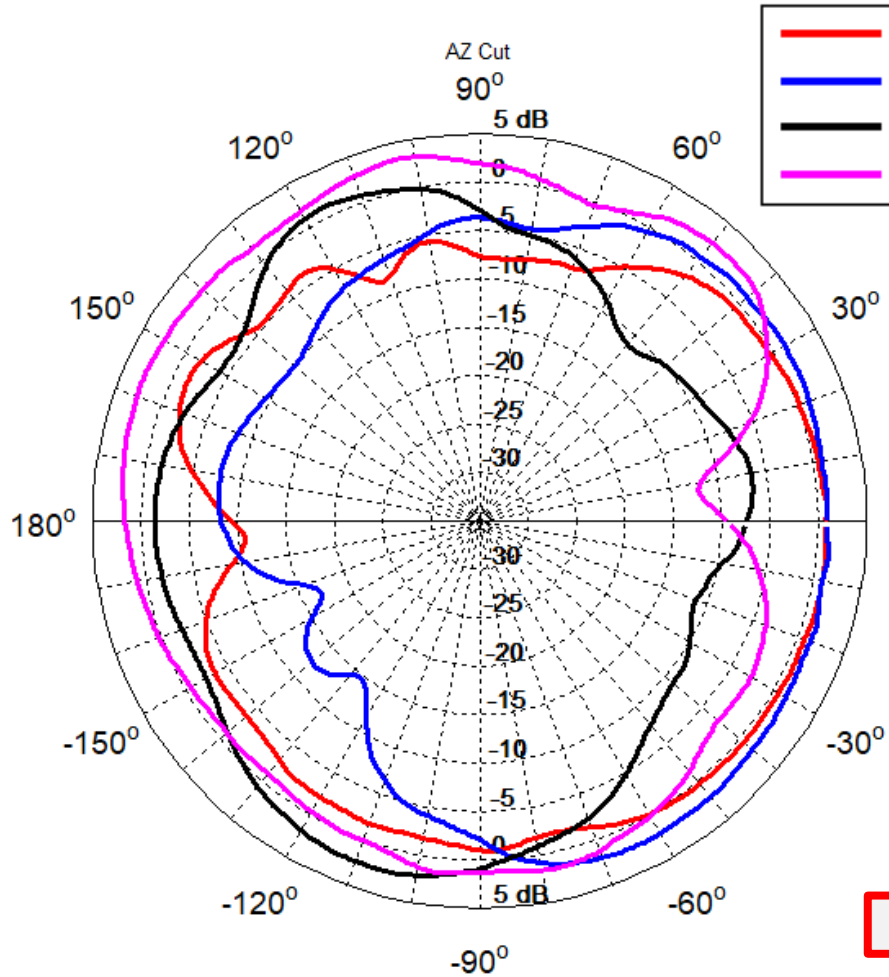


Front

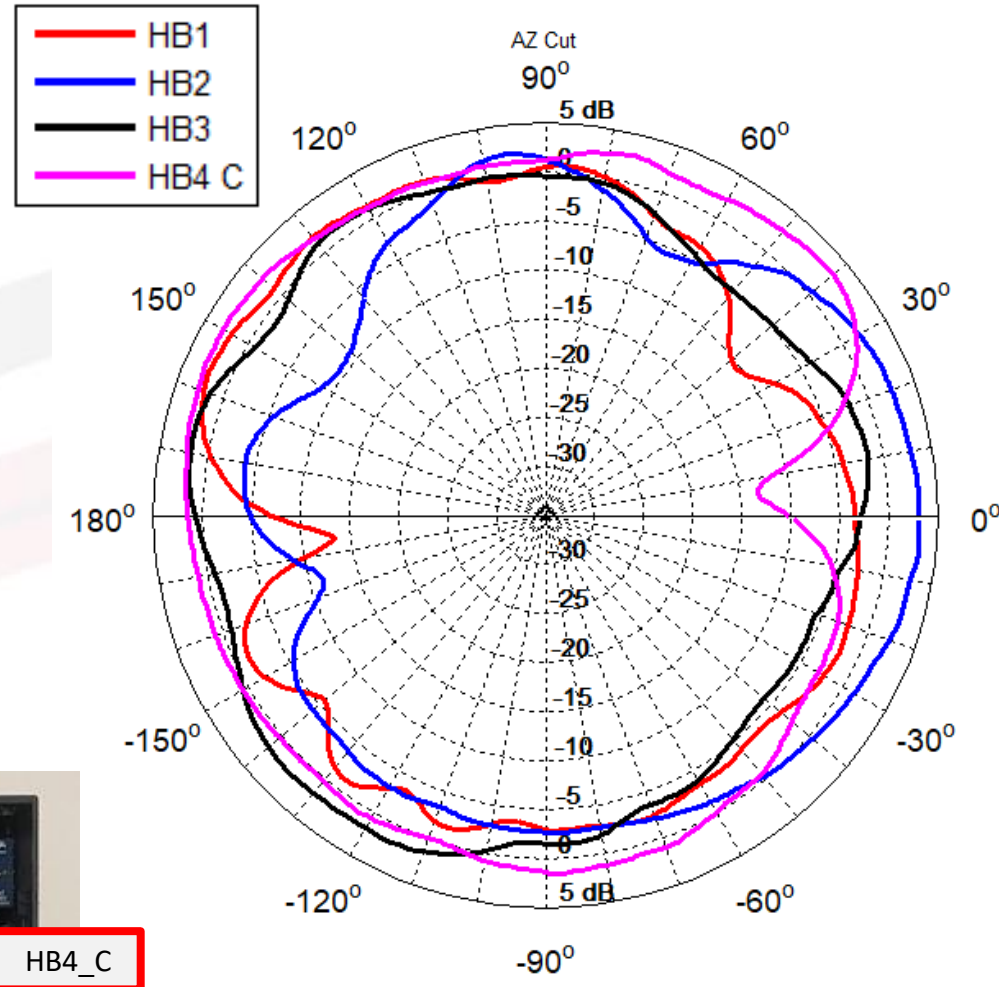
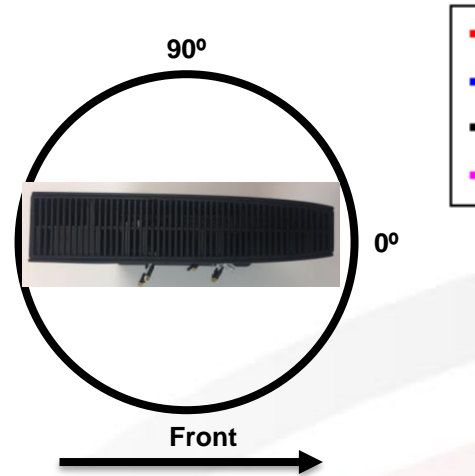
Azimuth Cut - Power Sum System Coverage – High Band



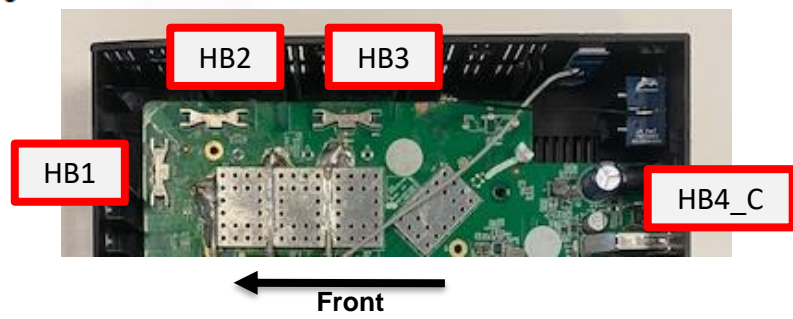
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High Band – 5.25 GHz



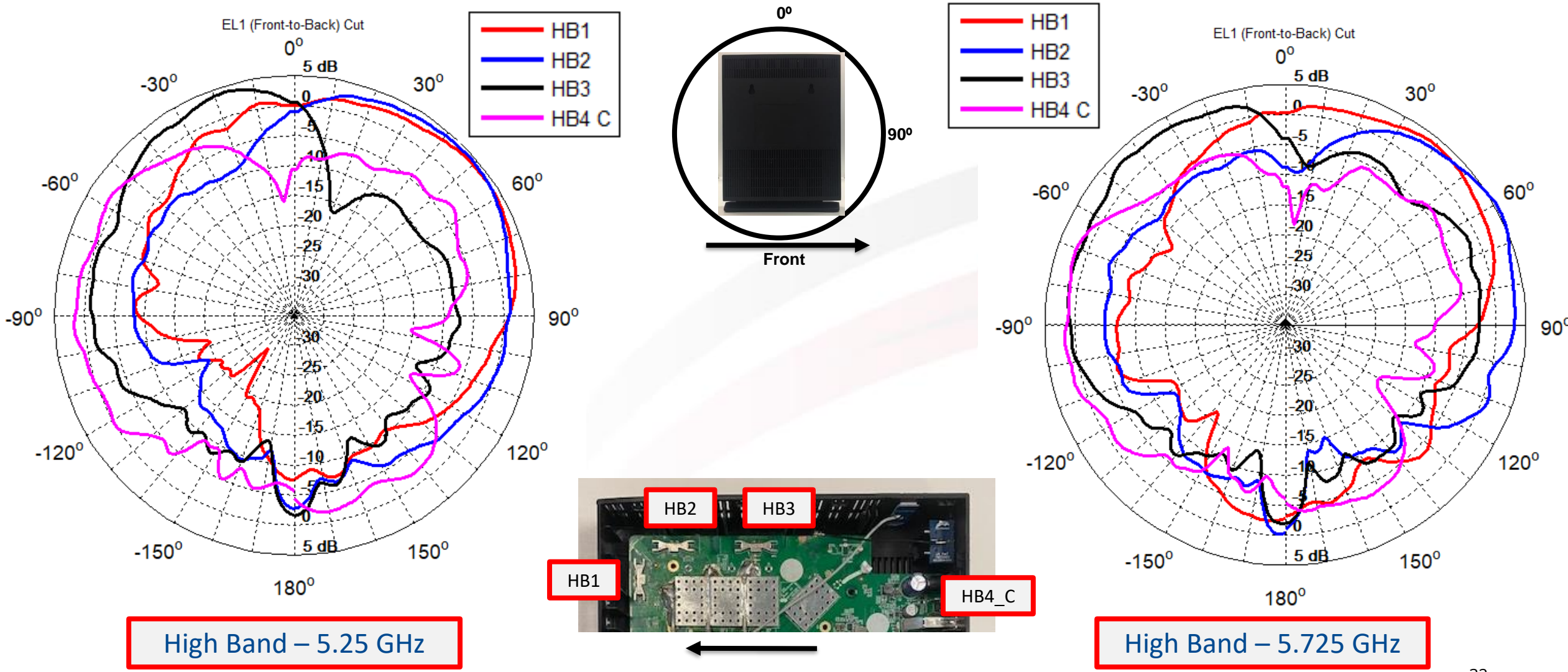
High Band – 5.725 GHz



Elevation (Front to Back) Cut - Power Sum System Coverage – High Band



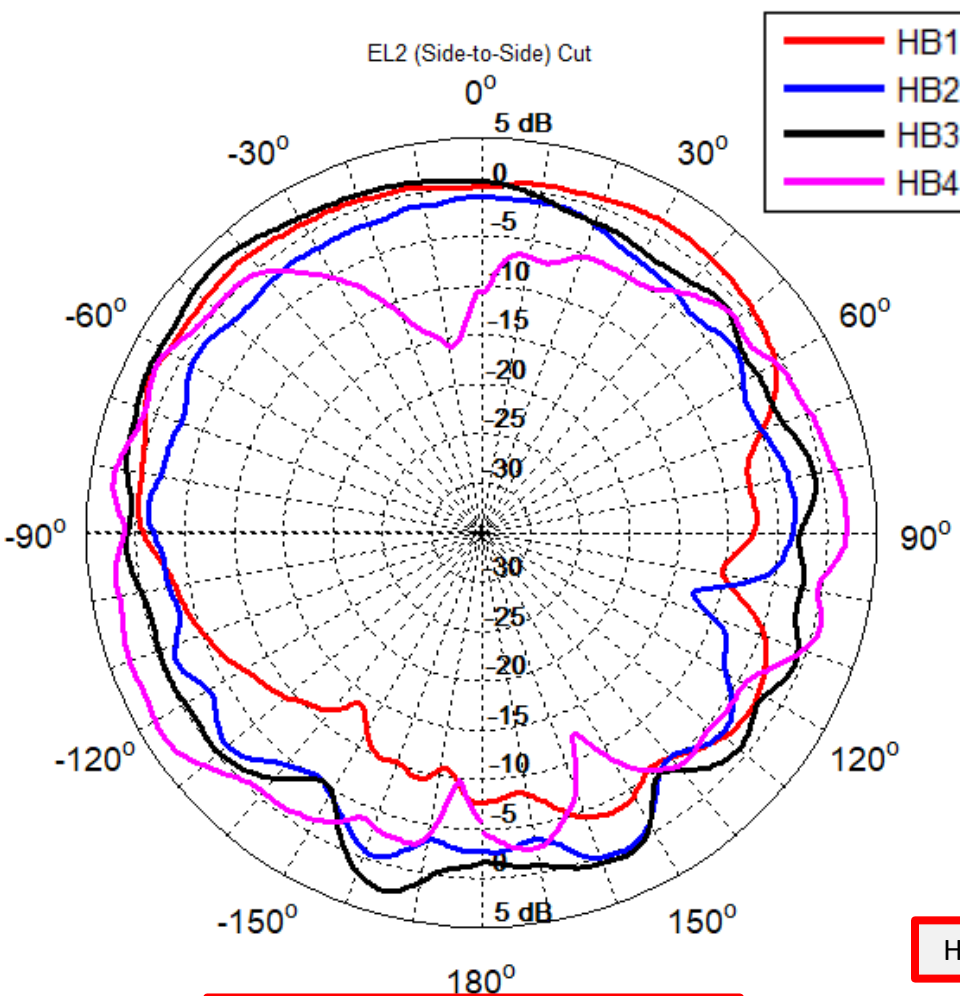
WE'RE MAKING WAVES™



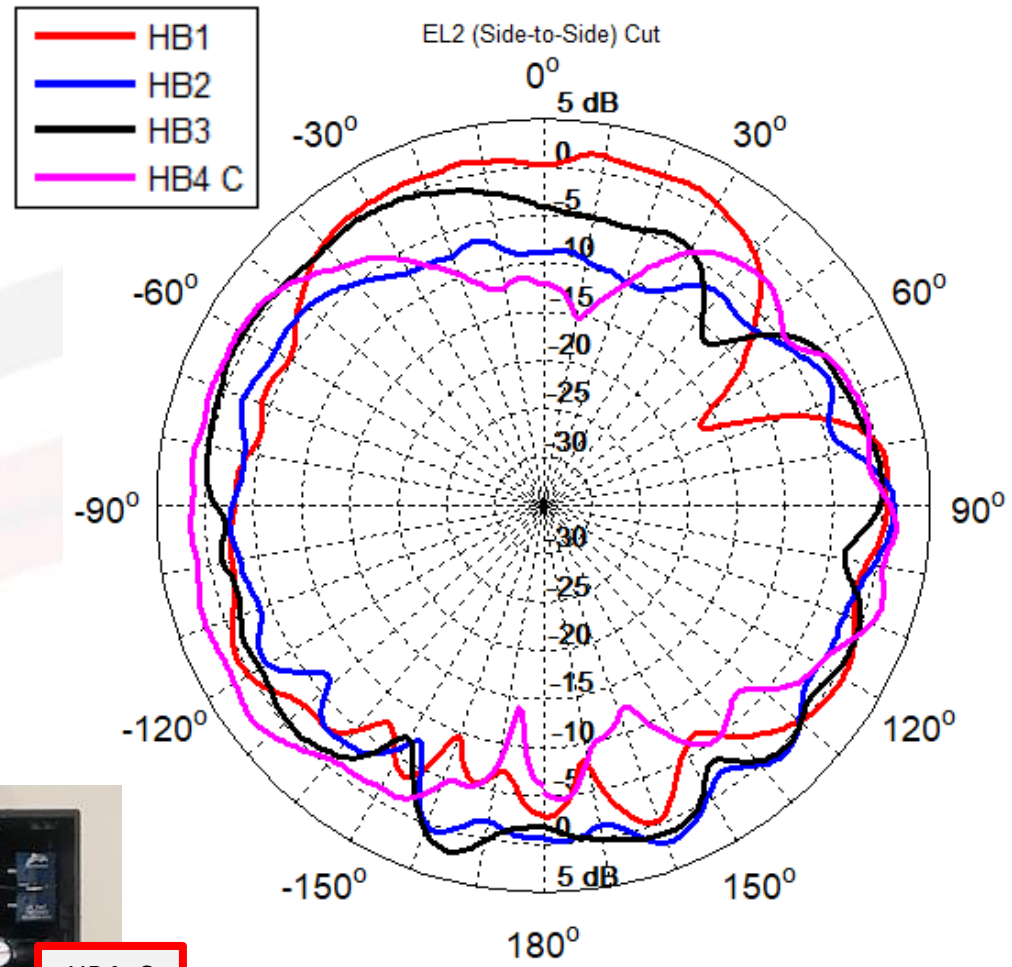
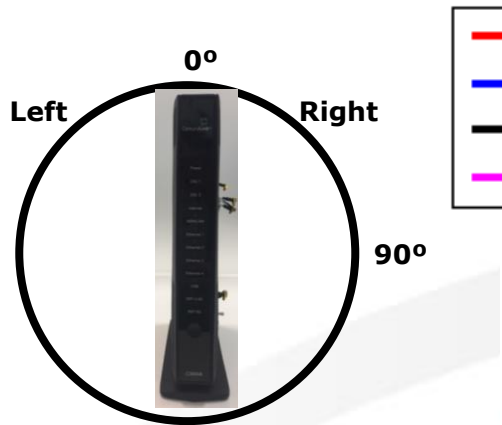
Elevation (Side to Side) Cut - Power Sum System Coverage – High Band



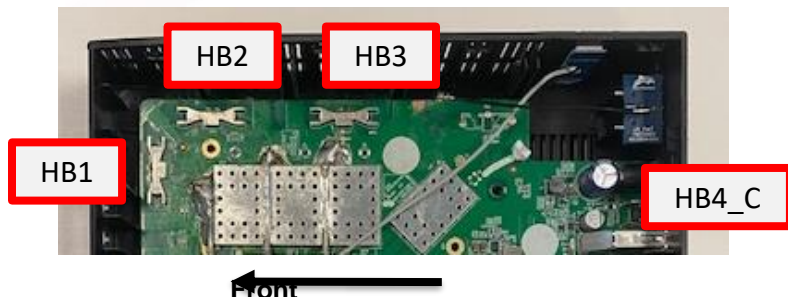
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High Band – 5.25 GHz



High Band – 5.725 GHz



Antenna Performance Summary



W E ' R E M A K I N G W A V E S ™

Antenna	Worst Case Return Loss (dB) 2.45 GHz Band	Worst Case Return Loss (dB) 5 GHz Band	Average Efficiency 2.45 GHz Band (%)	Average Efficiency 5 GHz Band (%)	Highest Peak Gain 2.45 GHz Band (dBi)	Highest Peak Gain 5 GHz Band (dBi)	Mutual Isolation (dB) 2.45 GHz Band			Mutual Isolation (dB) 5 GHz Band			
							LB1_C	LB2	LB3	HB1	HB2	HB3	HB4_C
LB1_C	-15.4		66.8%		3.47					-42.6	-42.6	-33.6	-36.0
LB2	-17.5		76.4%		4.91		-34.5			-33.0	-34.3	-38.8	-41.4
LB3	-19.7		70.1%		4.24		-39.8	-21.0		-35.0	-49.4	-48.8	-52.5
HB1		-17.7		67.6%		4.71	-28.8	-26.5	-24.1				
HB2		-14.5		66.6%		5.44	-26.1	-32.9	-24.8	-20.5			
HB3		-10.2		70.6%		4.61	-27.8	-42.3	-35.0	-33.7	-30.0		
HB4_C		-14.2		76.1%		3.44	-33.7	-40.2	-44.3	-43.7	-38.7	-31.4	

GLOBAL LOCATIONS



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Bac Ninh province, Vietnam

A photograph of two dolphins leaping from the ocean at sunset. The dolphins are in mid-air, their bodies curved as they move from left to right. The sun is low on the horizon, creating a bright, golden glow that illuminates the sky and the water. The sky is filled with soft, wispy clouds, and the water shows gentle ripples. The overall mood is serene and dynamic.

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Appendix A – 2.4G Correlated and Uncorrelated Result

Freq (MHz)	2400	2450	2500
Correlated Gain	5.34	5.37	5.90
Uncorrelated Gain	1.49	1.81	2.27

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	1512	1513	1514	1515	1516	1517	1518	1519	1520	1521	1522	1523	1524	1525	1526	1527	1528	1529	1530	1531	1532	1533	1534	1535	1536	1537	1538	1539	1540	1541	1542	1543	1544	1545	1546	1547	1548	1549	1550	1551	1552	1553	1554	1555	1556	1557	1558	1559	1560	1561	1562	1563	1564	1565	1566	1567	1568	1569	1570	1571	1572	1573	1574	1575	1576	1577	1578	1579	1580	1581	1582	1583	1584	1585	1586	1587	1588	1589	1590	1591	1592	1593	1594	1595	1596	1597	1598	1599	1600	1601	1602	1603	1604	1605	1606	1607	1608	1609	1610	1611	1612	1613	1614	1615	1616	1617	1618	1619	1620	1621	1622	1623	1624	1625	1626	1627	1628	1629	1630	1631	1632	1633	1634	1635	1636	1637	1638	1639	1640	1641	1642	1643	1644	1645	1646	1647	1648	1649	1650	1651	1652	1653	1654	1655	1656	1657	1658	1659	1660	1661	1662	1663	1664	1665	1666	1667	1668	1669	1670	1671	1672	1673	1674	1675	1676	1677	1678	1679	1680	1681	1682	1683	1684	1685	1686	1687	1688	1689	1690	1691	1692	1693	1694	1695	1696	1697	1698	1699	1700	1701	1702	1703	1704	1705	1706	1707	1708	1709	1710	1711	1712	1713	1714	1715	1716	1717	1718	1719	1720	1721	1722	1723	1724	1725	1726	1727	1728	1729	1730	1731	1732	1733	1734	1735	1736	1737	1738	1739	1740	1741	1742	1743	1744	1745	1746	1747	1748	1749	1750	1751	1752	1753	1754	1755	1756	1757	1758	1759	1760	1761	1762	1763	1764	1765	1766	1767	1768	1769	1770	1771	1772	1773	1774	1775	1776	1777	1778	1779	1780	1781	1782	1783	1784	1785	1786	1787	1788	1789	1790	1791	1792	1793	1794	1795	1796	1797	1798	1799	1800	1801	1802	1803	1804	1805	1806	1807	1808	1809	1810	1811	1812	1813	1814	1815	1816	1817	1818	1819	1820	1821	1822	1823	1824	1825	1826	1827	1828	1829	1830	1831	1832	1833	1834	1835	1836	1837	1838	1839	1840	1841	1842	1843	1844	1845	1846	1847	1848	1849	1850	1851	1852	1853	1854	1855	1856	1857	1858	1859	1860	1861	1862	1863	1864	1865	1866	1867	1868	1869	1870	1871	1872	1873	1874	1875	1876	1877	1878	1879	1880	1881	1882	1883	1884	1885	1886	1887	1888	1889	1890	1891	1892	1893	1894	1895	1896	1897	1898	1899	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
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Appendix A – 5G Correlated and Uncorrelated Result

Freq (MHz)	5150	5250	5350	5725	5825
Correlated Gain	5.48	6.20	6.69	6.66	5.24
Uncorrelated Gain	0.68	1.37	1.80	1.54	-0.17

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