



Antenna Composite Gain Test Report

Equipment	AX7800 Tri Band WiFi Router AX6600 Tri Band WiFi Router
Brand Name	ASUS
Model Name	ZenWiFi XT9/ASUS ZenWiFi XT9/XT8/BR-XT9/ZenWiFi Business BR-XT9/XT9
Applicant	ASUSTeK COMPUTER INC. 1F., No. 15, Lide Rd., Beitou Dist., Taipei City 112, Taiwan
Manufacturer (1)	Compal Networking(KunShan) CO., LTD. No.520,Nan Bang RD., Economic & Technical Development Zone, KunShan,JiangSu,China
Manufacturer (2)	ARCADYAN TECHNOLOGY (VIETNAM) CO., LTD. No. D4-5-6, Thang Long Industrial Park (Vinh Phuc), Thien Ke Commune, Binh Xuyen District, Vinh Phuc Province, Vietnam
Sample Received	Oct. 19, 2021
Start Test Date	Mar. 18, 2022
Final Test Date	Mar. 18, 2022



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History of this test report

[illegible]



1. Operation Mode and Antenna Information

Antenna Position	RF Port	Brand Name	Model Name	Ant. Type	Connector	Modes of Operation
2G 5GL Ant1	2	PSA	RFDPA230508IMLB902	Dipole	I-PEX	WLAN 2.4GHz+WLAN 5GHz UNII 1, UNII2A
2G 5GL Ant2	1	PSA	RFDPA230508IMLB902	Dipole	I-PEX	
5GH 5.9G Ant1	3	PSA	RFDPA230508IMLB902	Dipole	I-PEX	WLAN 5GHz UNII 2C ~ UNII4
5GH 5.9G Ant2	1	PSA	RFDPA230508IMLB902	Dipole	I-PEX	
5GH 5.9G Ant3	2	PSA	RFDPA230508IMLB902	Dipole	I-PEX	
5GH 5.9G Ant4	4	PSA	RFDPA230508IMLB902	Dipole	I-PEX	

Note:

Operation Mode (2TX/2RX):

2G 5GL Ant1~2G 5GL Ant2 can be used as transmitting/receiving antenna.

2G 5GL Ant1~2G 5GL Ant2 could transmit/receive simultaneously.

Operation Mode (4TX/4RX):

5GH 5.9G Ant1~5GH 5.9G Ant4 can be used as transmitting/receiving antenna.

5GH 5.9G Ant1~5GH 5.9G Ant4 could transmit/receive simultaneously.

2. Test Frequency

The listed frequency of each bands are selected to represent each frequency bands

Band [MHz]	Test Frequency [MHz]
2400-2483.5	2450
5150-5250	5200
5250-5350	5300
5470-5725	5600
5725-5850	5785
5850-5895	5885

3. Testing Location

Testing Location		
☒	HWA YA	ADD : No.13-1 & 14-1, Ln. 19, Wen 33rd St., Guishan Dist., Taoyuan City 333, Taiwan R.O.C.

Test Condition	Test Site No.	Test Engineer	Test Environment (°C / %)	Test Date
Radiated	05CH03-HY	Rex Liao	23.5-24.5 / 50-55	Mar. 18, 2022

Note:

Testing Site Information

Brand Name: TDK

Dimension: 11m*6m*6m

Characteristic: Fully Anechoic Chamber

4. Test Facility and Configuration

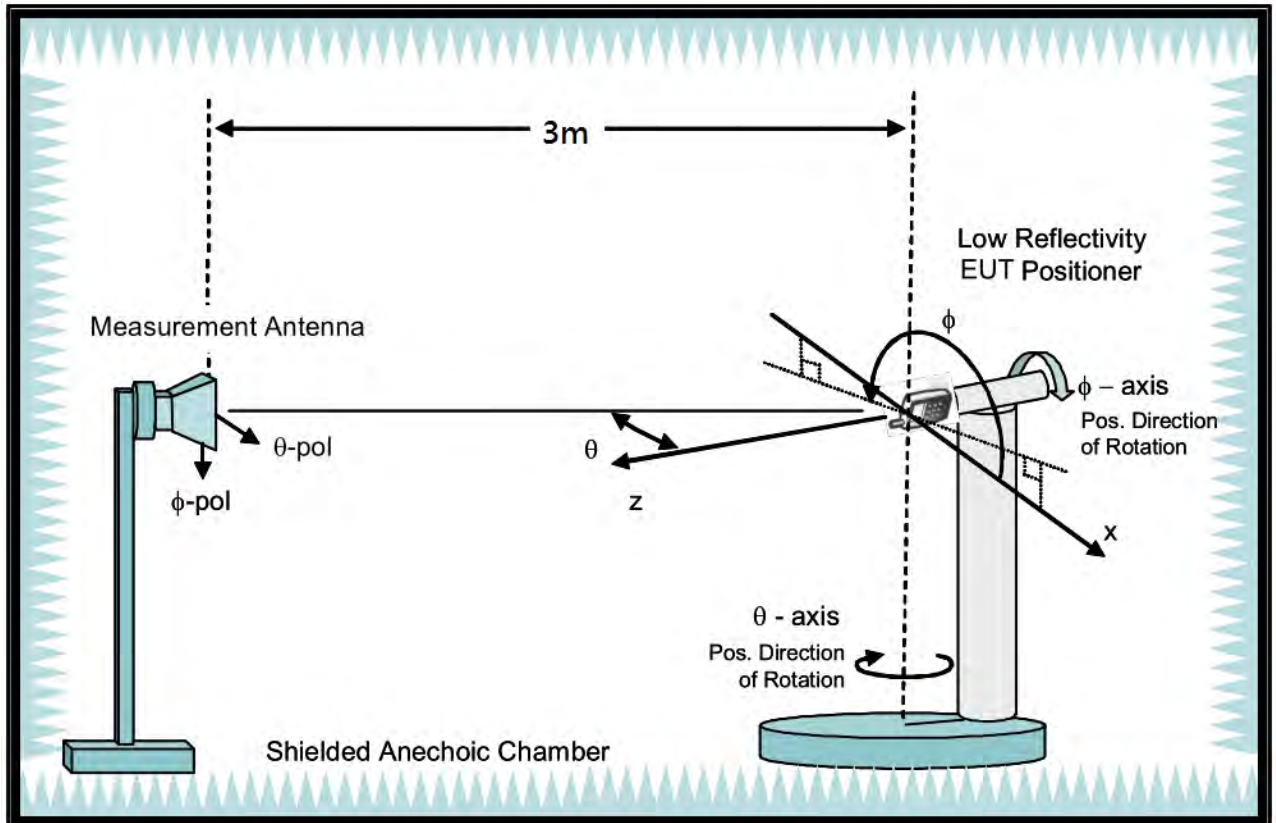
Test configuration: Reference to CITA OTA distributed-axes system configuration.

Chamber: Fully Anechoic Chamber.

Measurement antenna: Single Polarization Horn antenna calibrated according to ANSI C63.5.

Turntable: Multi-axis positioner (Theta and Phi angle).

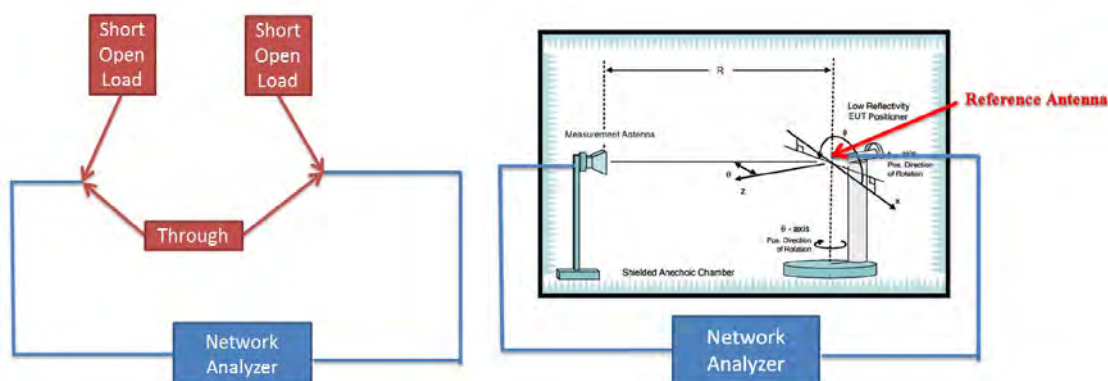
#Reference to CTIA "ctia-test-plan-for-wireless-device-over-the-air-performance-ver-3-7-1"



5. Reference Calibration

Connected cables to VNA calibration kit and use network analyzer internal function to do calibration. Do short, open and load to each side. Then connect through to both side and calibrate S21 values. The cable loss is calibrated and set inside the network analyzer.

Measurement Antenna is connected to port1 of Network analyzer and reference antenna connected to port 2 of Network Analyzer. Record S21 values and used with reference antenna gain to calculate gain factor.



Frequency (MHz)	2400	2450	2500	5150	5200	5300	5600	5750	5800	5900	6000	6500	7000	7500
S21 values (dBi)	-31.4	-31.4	-31.3	-31.3	-31	-30.7	-30.1	-30.5	-30.5	-30.8	-31.3	-32.8	-34.4	-35.4
Reference gain (dBi)	10.2	10.4	10.6	12.4	12.8	13.4	13.4	13.3	13.3	13.1	13.2	12.3	11.7	11.1
Factor (dB)	41.63	41.81	41.89	43.72	43.78	44.12	43.5	43.78	43.76	43.88	44.45	45.14	46.08	46.51

6. Test Method

EUT set on multi-axis positioner and adjust EUT's physical center to measurement reference center. Measurement antenna set at phi polarization and 1.5 meter height. Port 1 of Network analyzer connect to antenna 1 of EUT. Record S21 value every 15 degree from 0 to 345 degree on Phi angle and 0 to 180 on theta angle of multi-axis positioner. Then set measurement antenna to theta polarization and repeat process. Repeat process to each antenna of EUT.

DG steps:

1. Each Phi and Theta polarization antenna gain are measured for all test angles.
2. Composite Phi and Theta antenna gain are computed, using formula in KDB662911 D01 F. 2) e) (ii), for all angles.
3. Composite antenna gain are examined for all angles to determine max gain and Phi/Theta position. Max gain and phi/theta position are listed in section 7 tables.

7. Measured Values and Calculation of Maximum Gain Positions

For 2G 5GL Ant1~2G 5GL Ant2

DG_1SS Max Value Position

Frequency (Hz)	2.45G	5.2G	5.3G
Ant. 1 (dBi)	3.29	2.91	4.45
Ant. 2 (dBi)	1.33	2.73	0.12
DG [1SS] (dBi)	5.38	5.83	5.56
Polarization	Theta	Theta	Theta
$\Theta(^{\circ})$	80	90	90
$\Phi(^{\circ})$	90	250	180

Note: The DG 1SS max value position is the maximum value of section 11 table DG 1SS Result.

DG_1SS Max Value Position Calculation

Frequency (Hz)	2.45G	5.2G	5.3G
Ant. 1 [$10^{(G/20)}$]	$10^{(3.29/20)}$	$10^{(2.91/20)}$	$10^{(4.45/20)}$
Ant. 2 [$10^{(G/20)}$]	$10^{(1.33/20)}$	$10^{(2.73/20)}$	$10^{(0.12/20)}$
Ant. 1 [$10^{(G/20)}$] value	1.46	1.398	1.669
Ant. 2 [$10^{(G/20)}$] value	1.165	1.369	1.014
Sum All Antenna [Amax]	2.626	2.767	2.683
DG [$10 \cdot \log(A_{max}^2/N_{ant})$]	5.38	5.83	5.56

Note:

Directional Gain (1SS) is the max value of every look angle. Each position value is calculated by KDB662911 D01 d) (i).

$$\text{Directional gain (1SS)} = 10 \cdot \log(10^{(G_{ant1}/20)} + 10^{(G_{ant2}/20)} + 10^{(G_{ant3}/20)} + 10^{(G_{ant4}/20)} + \dots)^{1/2/N_{ant}}$$

DG_2SS Max Value Position

Frequency (Hz)	2.45G	5.2G	5.3G
Ant. 1 (dBi)	3.86	2.91	4.45
Ant. 2 (dBi)	0.38	2.73	0.12
DG [4SS] (dBi)	2.46	2.82	2.8
Polarization	Theta	Theta	Theta
$\Theta(^{\circ})$	90	90	90
$\Phi(^{\circ})$	230	250	180

Note: The DG 2SS max value position is the maximum DG 2SS value calculated from section 11 table Gain Result.

DG_2SS Max Value Position Calculation

Frequency (Hz)	2.45G	5.2G	5.3G
Ant. 1 $((10^{(G/20)})^2)$	2.4322	1.9543	2.7861
Ant. 2 $((10^{(G/20)})^2)$	1.0914	1.875	1.028
Sum All Antenna	3.5236	3.8293	3.8141
DG $[10 \cdot \log(\text{sum all}/N_{\text{ant}})]$	2.46	2.82	2.8

Note: Directional Gain (2SS) is the max value of all position. Each position value is calculated by KDB662911 D01 (e) (ii).

$$g_{j,k} = 10^{(G/20)}$$

$$\text{Directional Gain (2SS)} = 10 \cdot \log((10^{(G_{\text{ant1}}/20)})^2 + (10^{(G_{\text{ant2}}/20)})^2 + (10^{(G_{\text{ant3}}/20)})^2 + (10^{(G_{\text{ant4}}/20)})^2 + \dots) / N_{\text{ant}})$$



For 5GH 5.9G Ant1~5GH 5.9G Ant4

DG_1SS Max Value Position

Frequency (Hz)	5.6G	5.785G	5.885G
Ant. 1 (dBi)	-0.8	-0.81	-0.41
Ant. 2 (dBi)	2.02	1.53	1.96
Ant. 3 (dBi)	-0.19	1.35	2.24
Ant. 4 (dBi)	1.97	2.02	2.66
DG [1SS] (dBi)	6.86	7.11	7.71
Polarization	Theta	Theta	Theta
$\Theta(^{\circ})$	80	90	90
$\Phi(^{\circ})$	270	230	230

Note: The DG 1SS max value position is the maximum value of section 11 table DG 1SS Result.

DG_1SS Max Value Position Calculation

Frequency (Hz)	5.6G	5.785G	5.885G
Ant. 1 [$10^{(G/20)}$]	$10^{(-0.8/20)}$	$10^{(-0.81/20)}$	$10^{(-0.41/20)}$
Ant. 2 [$10^{(G/20)}$]	$10^{(2.02/20)}$	$10^{(1.53/20)}$	$10^{(1.96/20)}$
Ant. 3 [$10^{(G/20)}$]	$10^{(-0.19/20)}$	$10^{(1.35/20)}$	$10^{(2.24/20)}$
Ant. 4 [$10^{(G/20)}$]	$10^{(1.97/20)}$	$10^{(2.02/20)}$	$10^{(2.66/20)}$
Ant. 1 [$10^{(G/20)}$] value	0.912	0.911	0.954
Ant. 2 [$10^{(G/20)}$] value	1.262	1.193	1.253
Ant. 3 [$10^{(G/20)}$] value	0.978	1.168	1.294
Ant. 4 [$10^{(G/20)}$] value	1.255	1.262	1.358
Sum All Antenna [Amax]	4.407	4.534	4.86
DG [$10 \cdot \log(A_{max}^2/N_{ant})$]	6.86	7.11	7.71

Note:

Directional Gain (1SS) is the max value of every look angle. Each position value is calculated by KDB662911 D01 d) (i).

Directional gain (1SS) = $10 \cdot \log(10^{(G_{ant1}/20)} + 10^{(G_{ant2}/20)} + 10^{(G_{ant3}/20)} + 10^{(G_{ant4}/20)} + \dots)^{2/N_{ant}}$

**DG_4SS Max Value Position**

Frequency (Hz)	5.6G	5.785G	5.885G
Ant. 1 (dBi)	-28.3	-0.81	-0.41
Ant. 2 (dBi)	0.43	1.53	1.96
Ant. 3 (dBi)	3.66	1.35	2.24
Ant. 4 (dBi)	2.6	2.02	2.66
DG [4SS] (dBi)	1.18	1.15	1.76
Polarization	Theta	Theta	Theta
$\Theta(^{\circ})$	100	90	90
$\Phi(^{\circ})$	190	230	230

Note: The DG 4SS max value position is the maximum DG 4SS value calculated from section 11 table Gain Result.

DG_4SS Max Value Position Calculation

Frequency (Hz)	5.6G	5.785G	5.885G
Ant. 1 $((10^{(G/20)})^2)$	0.0015	0.8299	0.9099
Ant. 2 $((10^{(G/20)})^2)$	1.1041	1.4223	1.5704
Ant. 3 $((10^{(G/20)})^2)$	2.3227	1.3646	1.6749
Ant. 4 $((10^{(G/20)})^2)$	1.8197	1.5922	1.845
Sum All Antenna	5.248	5.209	6.0002
DG $[10*\log(\text{sum all}/N_{\text{ant}})]$	1.18	1.15	1.76

Note: Directional Gain (4SS) is the max value of all position. Each position value is calculated by KDB662911 D01 (e) (ii).

$$g_{j,k} = 10^{(G/20)}$$

$$\text{Directional Gain (4SS)} = 10*\log((10^{(G_{\text{ant1}}/20)})^2 + (10^{(G_{\text{ant2}}/20)})^2 + (10^{(G_{\text{ant3}}/20)})^2 + (10^{(G_{\text{ant4}}/20)})^2 + \dots) / N_{\text{ant}})$$

8. Summary of Test Result

For 2G 5GL Ant1~2G 5GL Ant2

Freq(Hz)	2.45G	5.2G	5.3G
Ant. 1 Max Gain (dBi)	3.86	4.25	4.45
Ant. 2 Max Gain (dBi)	3.94	4.53	4.52
Ant. 1 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/90/230	Theta/90/180	Theta/90/180
Ant. 2 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/100/70	Theta/100/50	Theta/100/50
Max Gain (dBi)	3.94	4.53	4.52
DG [1SS] (dBi)	5.38	5.83	5.56
DG [2SS] (dBi)	2.46	2.82	2.8

Note:

- Each antenna max gain is the max value of measurement S21 of theta and phi through all measurement angles.
- The max gain is the max value of all antennas.

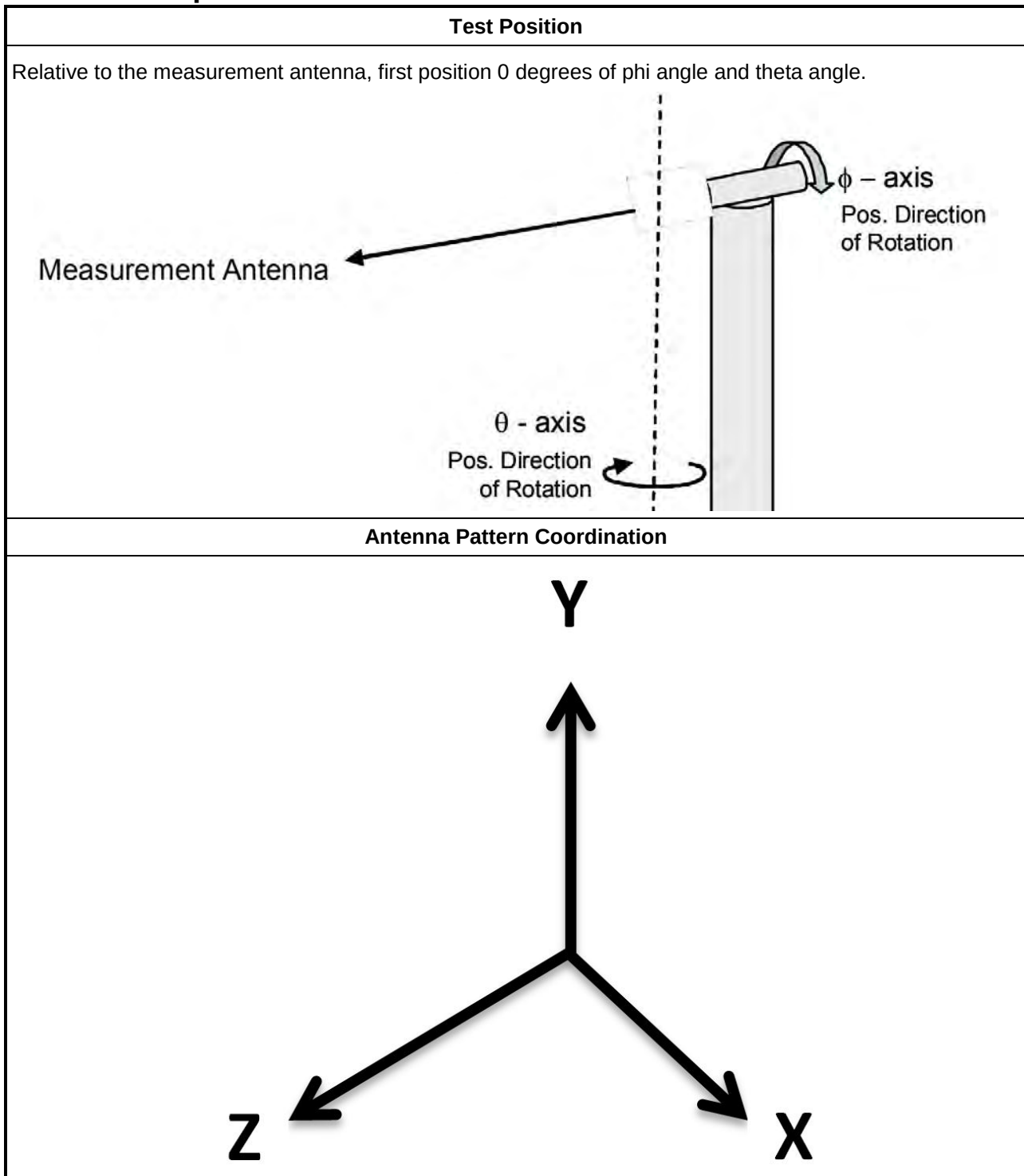
For 5GH 5.9G Ant1~5GH 5.9G Ant4

Freq(Hz)	5.6G	5.785G	5.885G
Ant. 1 Max Gain (dBi)	3.8	4.05	4.73
Ant. 2 Max Gain (dBi)	4.06	4.23	4.23
Ant. 3 Max Gain (dBi)	3.66	3.65	4.78
Ant. 4 Max Gain (dBi)	4.32	4.76	5.08
Ant. 1 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/100/40	Theta/100/40	Theta/100/40
Ant. 2 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/90/250	Theta/90/160	Theta/130/80
Ant. 3 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/100/190	Theta/60/340	Theta/60/350
Ant. 4 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/90/260	Theta/130/290	Theta/130/290
Max Gain (dBi)	4.32	4.76	5.08
DG [1SS] (dBi)	6.86	7.11	7.71
DG [2SS] (dBi)	4.32	4.76	5.08
DG [4SS] (dBi)	1.18	1.15	1.76

Note

- Directional Gain (2SS) = Directional Gain (1SS) – 3dB. If directional gain is less than max gain, use max gain as directional gain.
- Each antenna max gain is the max value of measurement S21 of theta and phi through all measurement angles.
- The max gain is the max value of all antennas.

9. Test Setup



Note:

Photos of Test Position: Please refer to the test photos in the appendix.

**10. Test Equipment and Calibration Data**

Instrument	Brand	Model No.	Serial No.	Characteristics	Calibration Date	Calibration Due Date
Horn Antenna	SCHWARZBECK	BBHA9120D	BBHA 9120D-1292	1GHz~18GHz	Aug. 04, 2021	Aug. 03, 2022
ENA Series Network Analyzer	AGILENT	E5071C	MY46419201	100kHz~8.5GHz	Feb. 21, 2022	Feb. 20, 2023
Test Software	SPORTON	SENSE-RDG	V1.0.6	-	N.C.R.	N.C.R.

Note: Calibration Interval of instruments listed above is one year.

NCR means Non-Calibration required.



11. Test Results

Please refer to the appendix.

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Freq(Hz)	2.45G	5.2G	5.3G
Ant. 1 Max Gain (dBi)	3.86	4.25	4.45
Ant. 2 Max Gain (dBi)	3.94	4.53	4.52
Ant. 1 Polarization/ $\theta(^{\circ})/\phi(^{\circ})$	Theta/90/230	Theta/90/180	Theta/90/180
Ant. 2 Polarization/ $\theta(^{\circ})/\phi(^{\circ})$	Theta/100/70	Theta/100/50	Theta/100/50
Max Gain (dBi)	3.94	4.53	4.52
DG [1SS] (dBi)	5.38	5.83	5.56
DG [2SS] (dBi)	2.46	2.82	2.8

Radiated Composite Gain of 2G 5GL Ant1~2G 5GL Ant2

Appendix A

Gain Result

Page	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	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	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	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	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	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	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	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360	361	362	363	364	365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380	381	382	383	384	385	386	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	491	492	493	494	495	496	497	498	499	500	501	502	503	504	505	506	507	508	509	510	511	512	513	514	515	516	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	829	830	831	832	833	834	835	836	837	838	839	840	841	842	843	844	845	846	847	848	849	850	851	852	853	854	855	856	857	858	859	860	861	862	863	864	865	866	867	868	869	870	871	872	873	874	875	876	877	878	879	880	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
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Freq(Hz)	5.6G	5.785G	5.885G
Ant. 1 Max Gain (dBi)	3.8	4.05	4.73
Ant. 2 Max Gain (dBi)	4.06	4.23	4.23
Ant. 3 Max Gain (dBi)	3.66	3.65	4.78
Ant. 4 Max Gain (dBi)	4.32	4.76	5.08
Ant. 1 Polarization/Θ(°)/Φ(°)	Theta/100/40	Theta/100/40	Theta/100/40
Ant. 2 Polarization/Θ(°)/Φ(°)	Theta/90/250	Theta/90/160	Theta/130/80
Ant. 3 Polarization/Θ(°)/Φ(°)	Theta/100/190	Theta/60/340	Theta/60/350
Ant. 4 Polarization/Θ(°)/Φ(°)	Theta/90/260	Theta/130/290	Theta/130/290
Max Gain (dBi)	4.32	4.76	5.08
DG [1SS] (dBi)	6.86	7.11	7.71
DG [2SS] (dBi)	4.32	4.76	5.08
DG [4SS] (dBi)	1.18	1.15	1.76

Radiated Composite Gain of 5GH 5.9G Ant1~5GH 5.9G Ant4

Appendix B

Gain Result

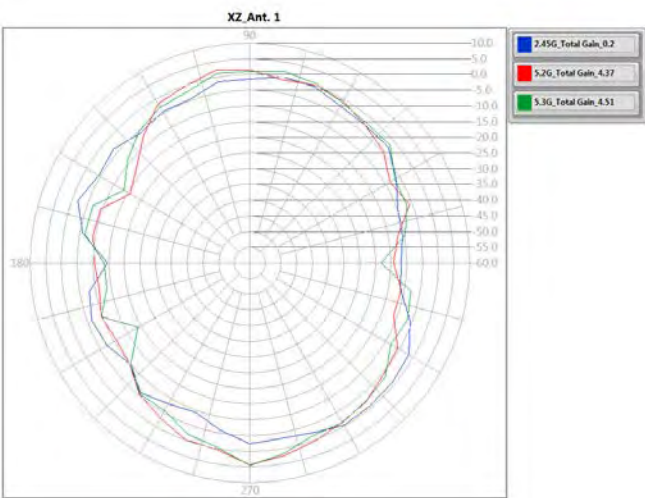
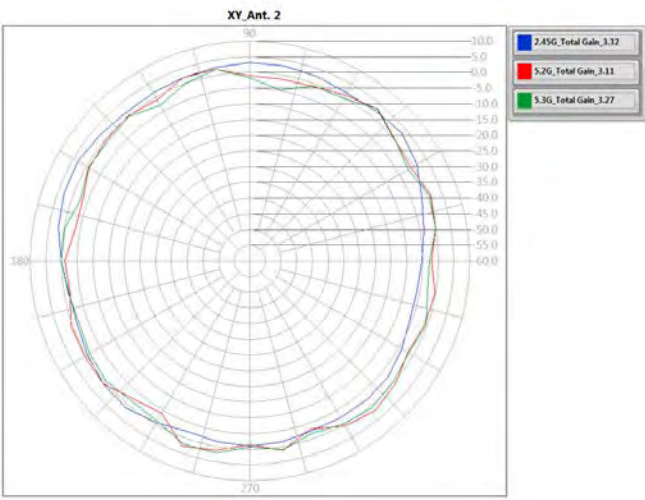
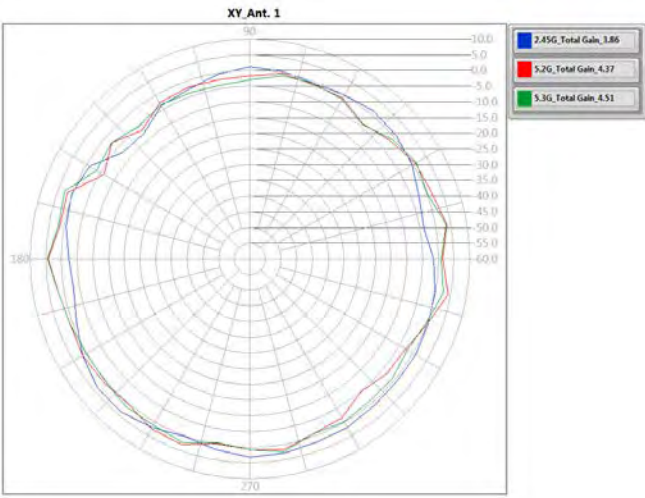
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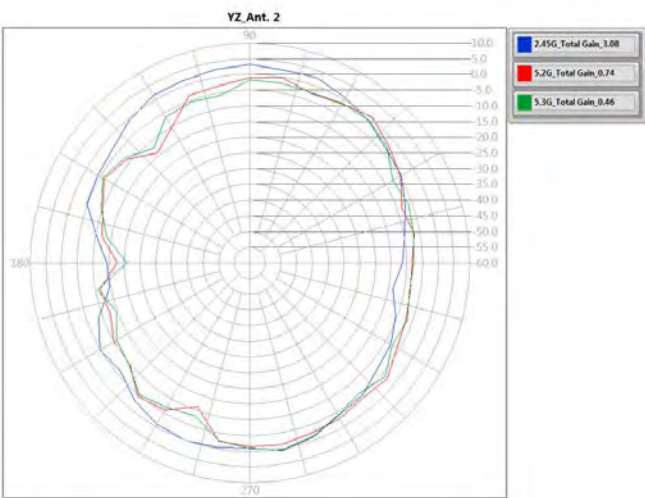
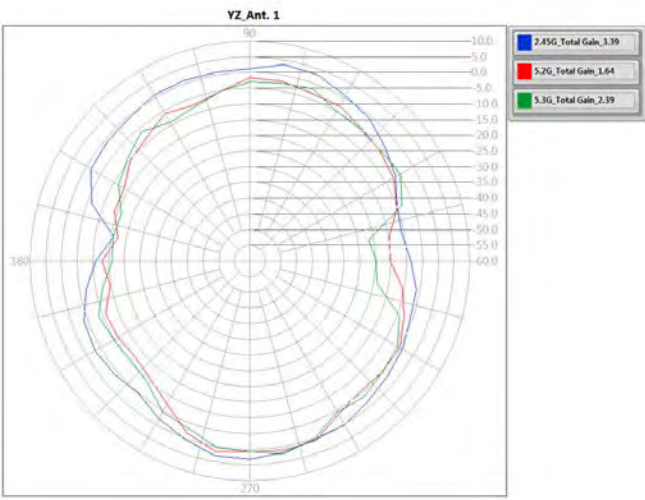
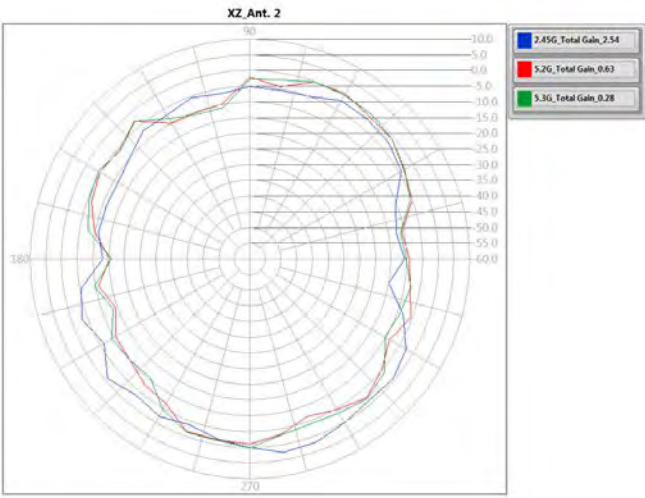
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Page No. : 5 of 5
Report No. : AP162917-01AC

Total Gain Data

[illegible]





Antenna Pattern of 5GH 5.9G Ant1~5GH 5.9G Ant4

Appendix D

Total Gain Data

[illegible]

