



Antenna Composite Gain Test Report

Equipment	DOCSIS 3.1 Residential Voice Gateway
Brand Name	Technicolor
Model Name	CGA437ATCH5 ; CGA437AXXXX (where X can be alphanumeric, -, or blank)
Applicant	Technicolor Connected Home USA LLC 4855 Peachtree Industrial Blvd. Suite 200 Norcross, Georgia 30092
Manufacturer	Technicolor Connected Home USA LLC 4855 Peachtree Industrial Blvd. Suite 200 Norcross, Georgia 30092
Sample Received	Mar. 30, 2022
Start Test Date	Apr. 06, 2022
Final Test Date	Apr. 07, 2022



Approved by: Jackson Tsai

SPORTON INTERNATIONAL INC. Hsinhua Laboratory

No.52, Huaya 1st Rd., Guishan Dist., Taoyuan City 333411, Taiwan (R.O.C.)



Table of Contents

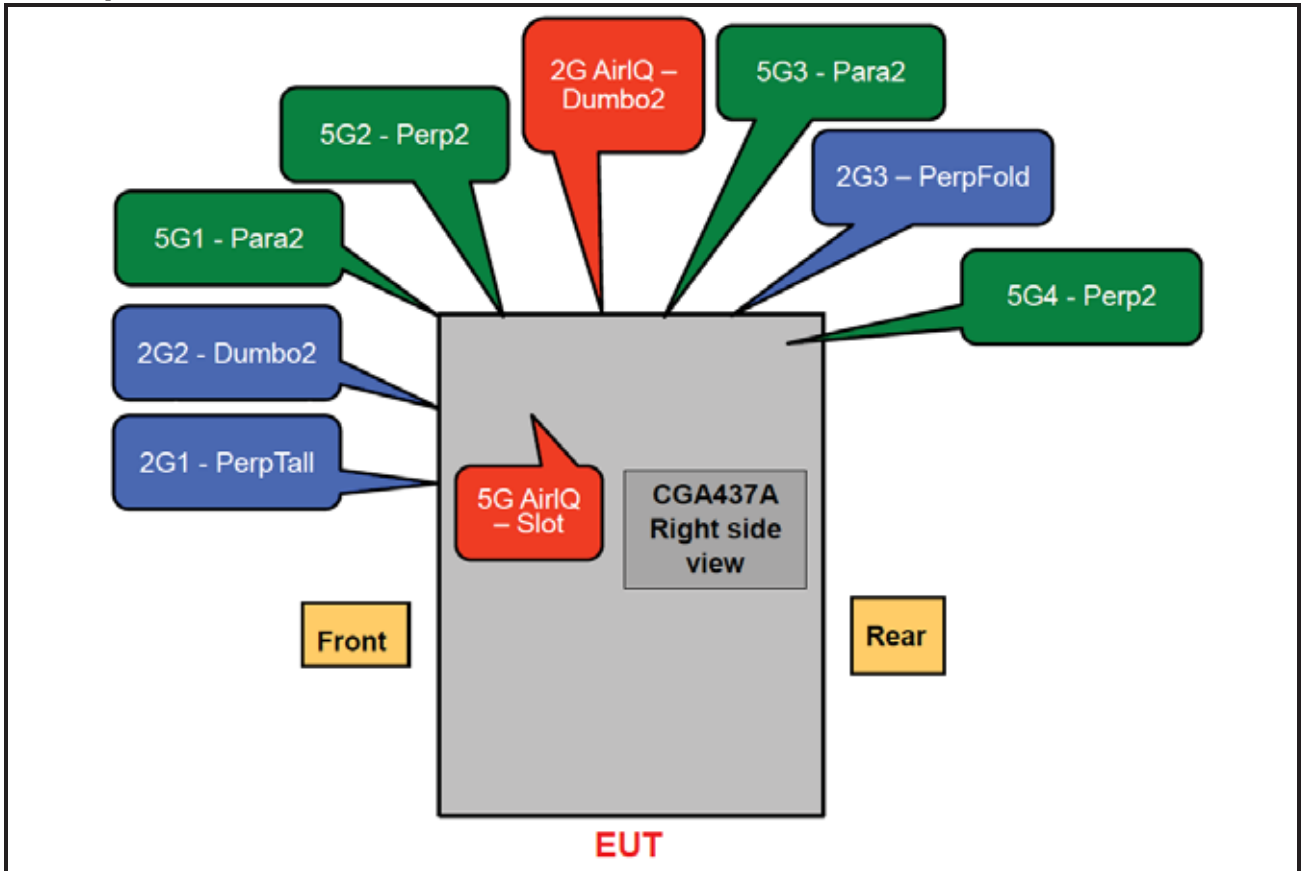
History of this test report.....	3
1. Operation Mode and Antenna Information	4
2. Test Frequency.....	5
3. Testing Location.....	5
4. Test Facility and Configuration	6
5. Reference Calibration	7
6. Test Method	8
7. Measured Values and Calculation of Maximum Gain Positions.....	9
8. Summary of Test Result	11
9. Test Setup	12
10. Test Equipment and Calibration Data	13
11. Test Results	14



History of this test report

Report No.	Version	Description	Issued Date
AP232914-01	01	Initial issue of report	Nov. 16, 2022
AP232914-01	02	Revise Antenna Location photo This report is the latest version replacing for the report issued on Nov. 16, 2022	Nov. 22, 2022

1. Operation Mode and Antenna Information



Antenna Position	RF Port	Brand Name	Model Name	Ant. Type	Connector	Modes of Operation
2G1 - PerpTall (Ant1)	1	Technicolor	2G1 - PerpTall	PIFA	I-PEX / UFL	2.4GHz
2G2 - Dumbo2 (Ant2)	2	Technicolor	2G2 - Dumbo2	PIFA	I-PEX / UFL	2.4GHz
2G3 - PerpFold (Ant3)	3	Technicolor	2G3 - PerpFold	PIFA	I-PEX / UFL	2.4GHz
5G1 - Para2 (Ant1)	1	Technicolor	5G1 - Para2	PIFA	I-PEX / UFL	5GHz
5G2 - Perp2 (Ant2)	2	Technicolor	5G2 - Perp2	PIFA	I-PEX / UFL	5GHz
5G3 - Para2 (Ant3)	3	Technicolor	5G3 - Para2	PIFA	I-PEX / UFL	5GHz
5G4 - Perp2 (Ant4)	4	Technicolor	5G4 - Perp2	PIFA	I-PEX / UFL	5GHz

Note:

2.4GHz Operation Mode (3TX/3RX)

2G1 - PerpTall (Ant1) ~ 2G3 - PerpFold (Ant3) could transmit/receive simultaneously.

5GHz Operation Mode (4TX/4RX)

5G1 - Para2 (Ant1) ~ 5G4 - Perp2 (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	2400
2400-2483.5	2450
2400-2483.5	2483.5
5150-5250	5200
5250-5350	5300
5470-5725	5600
5725-5850	5785

3. Testing Location

Test Lab. : Sporton International Inc. Hsinhua Laboratory				
<input checked="" type="checkbox"/> Wen 33rd.St.	ADD:	No.14-1, Ln. 19, Wen 33rd St., Guishan Dist., Taoyuan City 333010, Taiwan (R.O.C.)		
	TEL: 886-3-318-0787	FAX: 886-3-318-0287		
Test Condition	Test Site No.	Test Engineer	Test Environment	Test Date
Radiated	05CH03-HY	Rex Liao	23.5~24.5°C / 40~50%	06/Apr/2022~07/Apr/2022

Note:

Testing Site Information

Brand Name: TDK

Dimension: 11m*6m*6m

Characteristic: Fully Anechoic Chamber

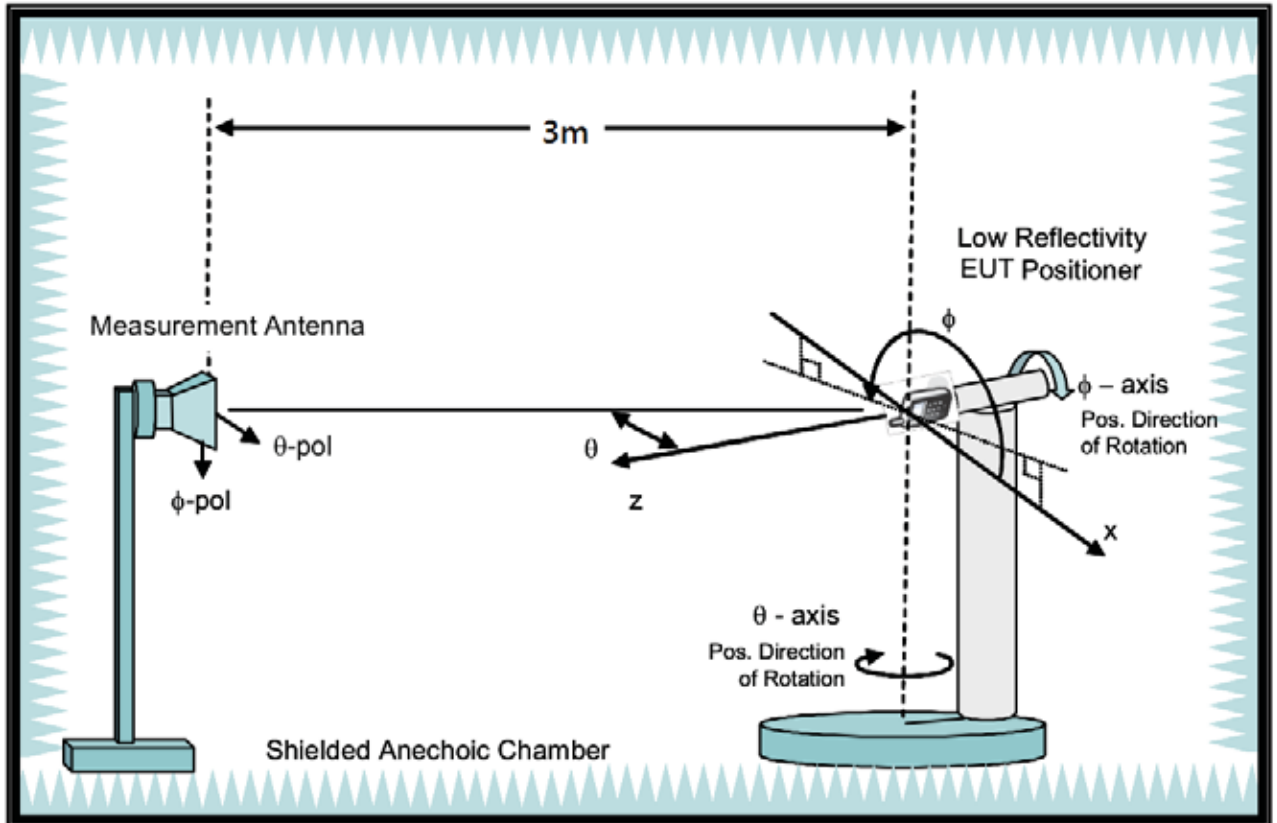
4. Test Facility and Configuration

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.

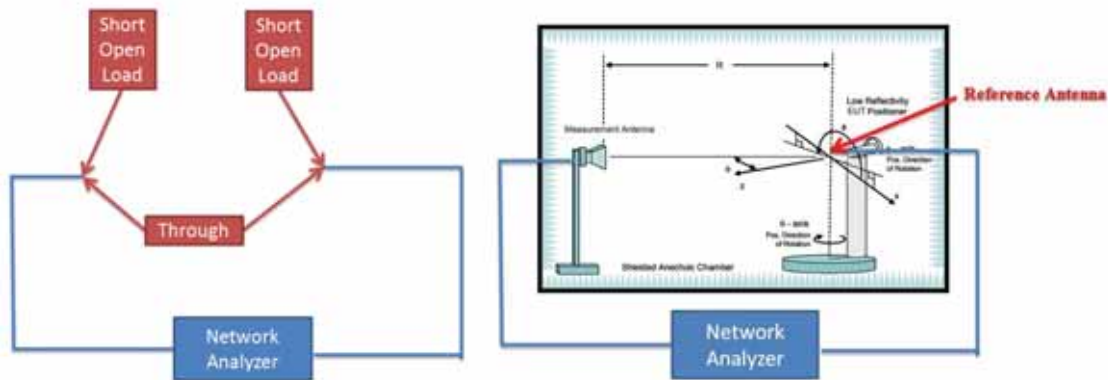
#Reference to CTIA “ctia-test-plan-for-wireless-device-over-the-air-performance-ver-3-7-1”



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 G 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 G 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
G reading (dB)	-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)	41.34	41.55	41.68	43.24	43.56	43.68	43.79	43.91	43.99	44.43	44.49	45.24	46.12	46.31

Note:

$$G \text{ reading (dB)} = 20 \cdot \log(V2/V1) = 10 \cdot \log(P2/P1)$$

V2 is the voltage of VNA port2 is measured, V1 is the voltage of VNA port1 is the reference source.

P2 is the power of VNA port2 is measured, P1 is the power of VNA port1 is the reference source.

$$\text{Factor} = \text{gain factor} + \text{power gain conversion} = (\text{Reference antenna gain}) - (G \text{ reading})$$



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 G 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 d) (i) and 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.

Note: Antenna gain = G reading + factor, The factor of chapter five includes reference antenna gain factor and power gain conversion.



7. Measured Values and Calculation of Maximum Gain Positions

DG_1SS max value position

Frequency (Hz)	2.4G	2.45G	2.4835G
Ant. 1 (dBi)	2.88	3.08	2.96
Ant. 2 (dBi)	-16.42	-16.51	-16.93
Ant. 3 (dBi)	2.67	2.44	2.46
DG [1SS] (dBi)	4.49	4.47	4.4
Polarization	Phi	Phi	Phi
$\Theta(^{\circ})$	60	60	60
$\Phi(^{\circ})$	260	270	270

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)	2.4G	2.45G	2.4835G
Ant. 1 [$10^{(G/20)}$]	$10^{(2.88/20)}$	$10^{(3.08/20)}$	$10^{(2.96/20)}$
Ant. 2 [$10^{(G/20)}$]	$10^{(-16.42/20)}$	$10^{(-16.51/20)}$	$10^{(-16.93/20)}$
Ant. 3 [$10^{(G/20)}$]	$10^{(2.67/20)}$	$10^{(2.44/20)}$	$10^{(2.46/20)}$
Ant. 1 [$10^{(G/20)}$] value	1.393	1.426	1.406
Ant. 2 [$10^{(G/20)}$] value	0.151	0.149	0.142
Ant. 3 [$10^{(G/20)}$] value	1.36	1.324	1.327
Sum All Antenna [Amax]	2.904	2.899	2.876
DG [$10 \cdot \log(A_{max}^2/N_{ant})$]	4.49	4.47	4.4

Note:

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

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

**DG_1SS max value position**

Frequency (Hz)	5.2G	5.3G	5.6G	5.785G
Ant. 1 (dBi)	-4.76	-6.2	-3.68	-6.03
Ant. 2 (dBi)	-1.07	-1.27	2.53	2.28
Ant. 3 (dBi)	-2.73	-2.16	-2.26	-6.02
Ant. 4 (dBi)	-0.96	-1.82	-1.31	-1.75
DG [1SS] (dBi)	3.77	3.36	5.16	3.85
Polarization	Theta	Theta	Theta	Theta
$\Theta(^{\circ})$	50	50	60	60
$\Phi(^{\circ})$	160	160	350	350

DG_1SS max value position calculation

Frequency (Hz)	5.2G	5.3G	5.6G	5.785G
Ant. 1 [$10^{(G/20)}$]	$10^{(-4.76/20)}$	$10^{(-6.2/20)}$	$10^{(-3.68/20)}$	$10^{(-6.03/20)}$
Ant. 2 [$10^{(G/20)}$]	$10^{(-1.07/20)}$	$10^{(-1.27/20)}$	$10^{(2.53/20)}$	$10^{(2.28/20)}$
Ant. 3 [$10^{(G/20)}$]	$10^{(-2.73/20)}$	$10^{(-2.16/20)}$	$10^{(-2.26/20)}$	$10^{(-6.02/20)}$
Ant. 4 [$10^{(G/20)}$]	$10^{(-0.96/20)}$	$10^{(-1.82/20)}$	$10^{(-1.31/20)}$	$10^{(-1.75/20)}$
Ant. 1 [$10^{(G/20)}$] value	0.578	0.49	0.655	0.499
Ant. 2 [$10^{(G/20)}$] value	0.884	0.864	1.338	1.3
Ant. 3 [$10^{(G/20)}$] value	0.73	0.78	0.771	0.5
Ant. 4 [$10^{(G/20)}$] value	0.895	0.811	0.86	0.818
Sum All Antenna [Amax]	3.088	2.945	3.624	3.117
DG [$10^{*}\log(Amax^2/Nant)$]	3.77	3.36	5.16	3.85

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) = $10^{*}\log(10^{(G_{ant1}/20)}+10^{(G_{ant2}/20)}+10^{(G_{ant3}/20)}+10^{(G_{ant4}/20)}+.....)^2/N_{ant}$



8. Summary of Test Result

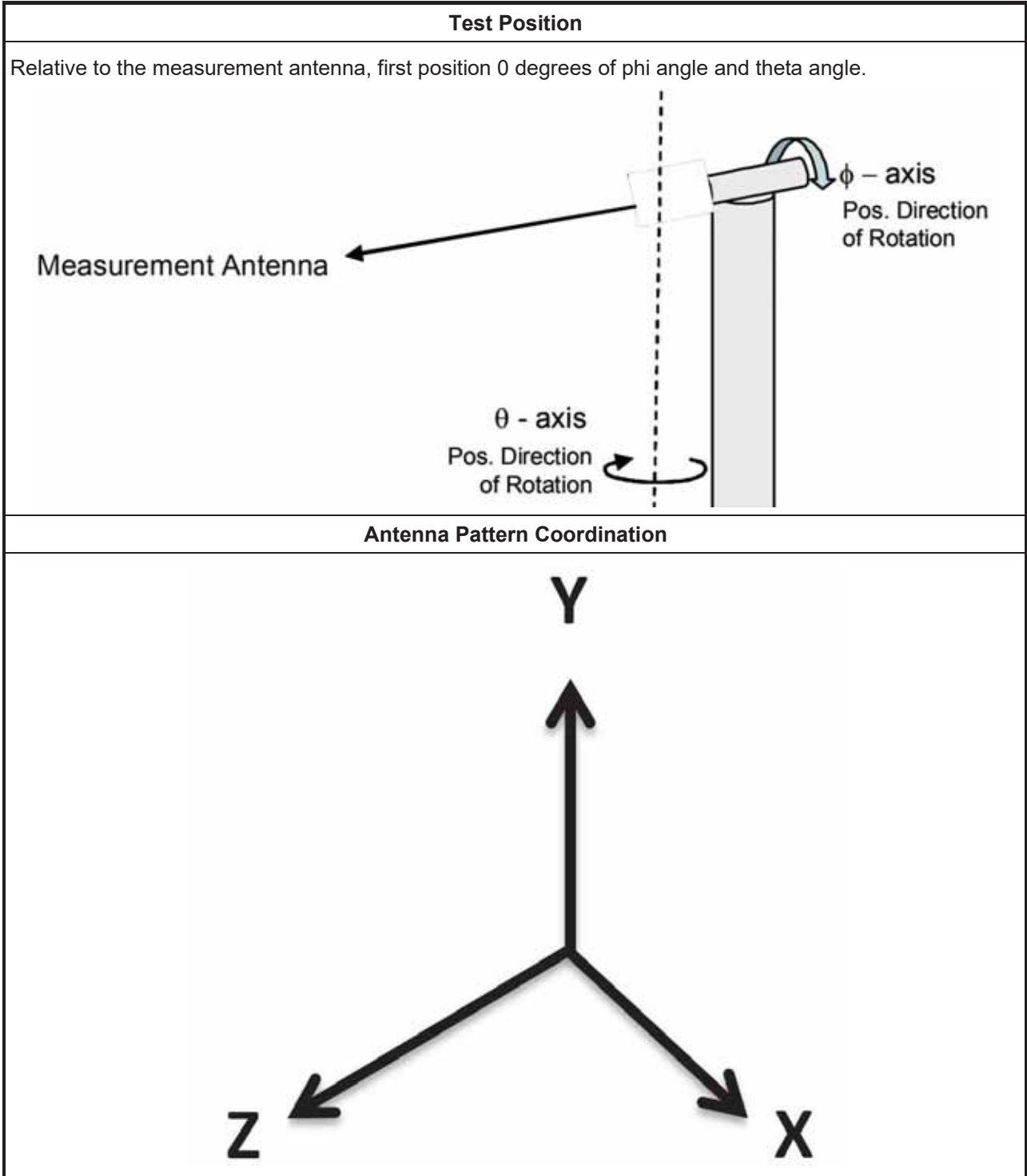
Frequency (Hz)	2.4G	2.45G	2.4835G
Ant. 1 Max Gain (dBi)	2.88	3.61	3.29
Ant. 2 Max Gain (dBi)	4.63	4.58	4.7
Ant. 3 Max Gain (dBi)	2.81	2.44	2.46
Ant. 1 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Phi/60/260	Phi/160/260	Phi/160/260
Ant. 2 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/100/300	Theta/100/300	Theta/110/300
Ant. 3 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Phi/50/270	Phi/60/270	Phi/60/270
Max Gain (dBi)	4.63	4.58	4.7
DG [1SS] (dBi)	4.49	4.47	4.4
DG [3SS] (dBi)	1.04	1.04	0.98

Frequency (Hz)	5.2G	5.3G	5.6G	5.785G
Ant. 1 Max Gain (dBi)	2.52	2.34	2.2	2.37
Ant. 2 Max Gain (dBi)	2.87	2.38	2.89	2.43
Ant. 3 Max Gain (dBi)	2.08	2.58	2.44	2.26
Ant. 4 Max Gain (dBi)	2.14	2.75	2.13	2.1
Ant. 1 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Phi/10/260	Theta/0/180	Phi/20/100	Phi/20/100
Ant. 2 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/70/190	Theta/80/180	Theta/70/350	Theta/60/340
Ant. 3 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Phi/140/90	Phi/140/90	Theta/20/0	Theta/150/160
Ant. 4 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Phi/90/230	Phi/100/230	Theta/130/260	Theta/130/290
Max Gain (dBi)	2.87	2.75	2.89	2.43
DG [1SS] (dBi)	3.77	3.36	5.16	3.85
DG [2SS] (dBi)	2.87	2.75	2.89	2.43
DG [4SS] (dBi)	-1.94	-1.71	-0.51	-1.46

Note:

1. Antenna max gain is the max value of each individual antenna through all measurement angles.
2. The max gain is the max value of all antennas.
3. Directional Gain (2SS) = Directional Gain (1SS) – 3dB. If directional gain is less than max gain, use max gain as directional gain.

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.

Appendix A – Radiated Composite Gain of 2.4 GHz.....	Page 15
Appendix B – Radiated Composite Gain of 5GHz.....	Page 20
Appendix C.1 – Antenna Pattern of 2.4GHz.....	Page 26
Appendix C.2 – Antenna Pattern of 5GHz.....	Page 29
Appendix D – Test Photos.....	Page 33

————THE END————



Radiated Composite Gain

Appendix A

Freq(Hz)	2.4G	2.45G	2.4835G
Ant. 1 Max Gain (dBi)	2.88	3.61	3.29
Ant. 2 Max Gain (dBi)	4.63	4.58	4.7
Ant. 3 Max Gain (dBi)	2.81	2.44	2.46
Ant. 1 Polarization $\Theta(^{\circ})/\Phi(^{\circ})$	Phi/60/260	Phi/160/260	Phi/160/260
Ant. 2 Polarization $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/100/300	Theta/100/300	Theta/110/300
Ant. 3 Polarization $\Theta(^{\circ})/\Phi(^{\circ})$	Phi/50/270	Phi/60/270	Phi/60/270
Max Gain (dBi)	4.63	4.58	4.7
DG [1SS] (dBi)	4.49	4.47	4.4
DG [3SS] (dBi)	1.04	1.04	0.98



Radiated Composite Gain

Appendix A

DG ISS Result

Step	Time	Power	Frequency	Power	Frequency	Power	Frequency	Power	Frequency	Power	Frequency	Power	Frequency	Power	Frequency	Power	Frequency	Power	Frequency
1	14:11:31	0.00	147.141	0.00	147.141	0.00	147.141	0.00	147.141	0.00	147.141	0.00	147.141	0.00	147.141	0.00	147.141	0.00	147.141



Radiated Composite Gain

Appendix A

Table with multiple columns and rows containing numerical data, likely representing gain values for various configurations.



Radiated Composite Gain

Appendix A

Model	Model	Model	Model	Model	Model	Model	Model	Model	Model	Model	Model	Model	Model	Model	Model	Model	Model	Model	Model
1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
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1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000



Radiated Composite Gain

Appendix B

Freq(Hz)	5.2G	5.3G	5.6G	5.785G
Ant. 1 Max Gain (dBi)	2.52	2.34	2.2	2.37
Ant. 2 Max Gain (dBi)	2.87	2.38	2.89	2.43
Ant. 3 Max Gain (dBi)	2.08	2.58	2.44	2.26
Ant. 4 Max Gain (dBi)	2.14	2.75	2.13	2.1
Ant. 1 Polarization $\Theta(^{\circ})/\Phi(^{\circ})$	Phi/10/260	Theta/0/180	Phi/20/100	Phi/20/100
Ant. 2 Polarization $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/70/190	Theta/80/180	Theta/70/350	Theta/60/340
Ant. 3 Polarization $\Theta(^{\circ})/\Phi(^{\circ})$	Phi/140/90	Phi/140/90	Theta/20/0	Theta/150/160
Ant. 4 Polarization $\Theta(^{\circ})/\Phi(^{\circ})$	Phi/90/230	Phi/100/230	Theta/130/260	Theta/130/290
Max Gain (dBi)	2.87	2.75	2.89	2.43
DG [1SS] (dBi)	3.77	3.36	5.16	3.85
DG [2SS] (dBi)	2.87	2.75	2.89	2.43
DG [4SS] (dBi)	-1.94	-1.71	-0.51	-1.46



Radiated Composite Gain

Appendix B

Gain Result

Table with multiple columns and rows containing numerical data, organized in a grid format. The table contains gain results for various configurations, with columns likely representing different parameters and rows representing individual test cases or configurations.



Antenna Pattern

Appendix C.1

Table with columns for elevation angle (Theta), azimuth angle (Phi), and gain values in dBS. The table is organized into multiple sections for different antenna patterns, including sections for Gain, Frequency, and various antenna configurations like 2425Pa, 2435Pa, 2455Pa, and 2485Pa. Each section contains a grid of gain values corresponding to specific elevation and azimuth angles.

E1 (XY plane) – $\Theta(90)\Phi(0-360)$
 E2 (XZ plane) – $\Theta(0-180)\Phi(0)$ and $\Theta(0-180)\Phi(180)$
 E3 (YZ plane) – $\Theta(0-180)\Phi(90)$ and $\Theta(0-180)\Phi(270)$





Antenna Pattern

Appendix C.2

Table with columns for elevation angle (Theta) and azimuth angle (Phi), and rows for various antenna models (e.g., 5.65PnL, 5.65PnR) and their corresponding gain values in dBS.



Antenna Pattern

Appendix C.2

Table with 18 columns and 100 rows. Columns include elevation angles (0 to 180 degrees), gain, and various dBS values for different antenna configurations.

E1(XY plane) – $\Theta(90)\Phi(0-360)$
 E2(XZ plane) – $\Theta(0-180)\Phi(0)$ and $\Theta(0-180)\Phi(180)$
 E3(YZ plane) – $\Theta(0-180)\Phi(90)$ and $\Theta(0-180)\Phi(270)$

