



Antenna Composite Gain Test Report

Equipment	Tri-Band Wireless BE18000 2.5G Ethernet Gateway
Brand Name	ZYXEL
Model Name	EE4410-00
Applicant	Zyxel Communications Corporation No.2 Industry East RD. IX, Hsinchu Science Park, Hsinchu 30075, Taiwan
Manufacturer	Zyxel Communications Corporation No.2 Industry East RD. IX, Hsinchu Science Park, Hsinchu 30075, Taiwan
Standard	KDB 662911 D03 v02
Sample Received	Jun. 01, 2025
Start Test Date	Jun. 01, 2025
Final Test Date	Jun. 01, 2025


Approved by: Jackson Tsai**SPORTON INTERNATIONAL INC. Hsinhua Laboratory**

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History of this test report

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1. Operation Mode and Antenna Information

Antenna Position	RF Port	Brand Name	Model Name	Ant. Type	Connector	Modes of Operation
5G ant1	1	HONGBO	290-11234	Dipole	I-pex	5G
5G ant2	2	HONGBO	290-11235	Dipole	I-pex	5G
5G ant3	3	HONGBO	290-11236	Dipole	I-pex	5G
5G ant4	4	HONGBO	290-11237	Dipole	I-pex	5G
6G ant1	1	HONGBO	290-11238	Dipole	I-pex	6G
6G ant2	2	HONGBO	290-11239	Dipole	I-pex	6G
6G ant3	3	HONGBO	290-11240	Dipole	I-pex	6G
6G ant4	4	HONGBO	290-11241	Dipole	I-pex	6G

Note:

5GHz Operation Mode (4TX/4RX)

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

6GHz Operation Mode (4TX/4RX)

6G Ant1~6G 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]
5150-5250	5200
5250-5350	5300
5470-5725	5600
5725-5850	5785
5925-6425	6175
6425-6525	6475
6525-6875	6695
6875-7125	6995



3. Testing Location

Test Lab. : Sporton International Inc. Hsinhua Laboratory				
☒ 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 (°C / %)	Test Date
Radiated	05CH03-HY	Rofy Chen	23.5~24.5°C / 45~55%	01/Jun/2025

Note:

Testing Site Information

Brand Name: TDK

Dimension: 11m*6m*6m

Characteristic: Fully Anechoic Chamber

4. Test Facility and Configuration

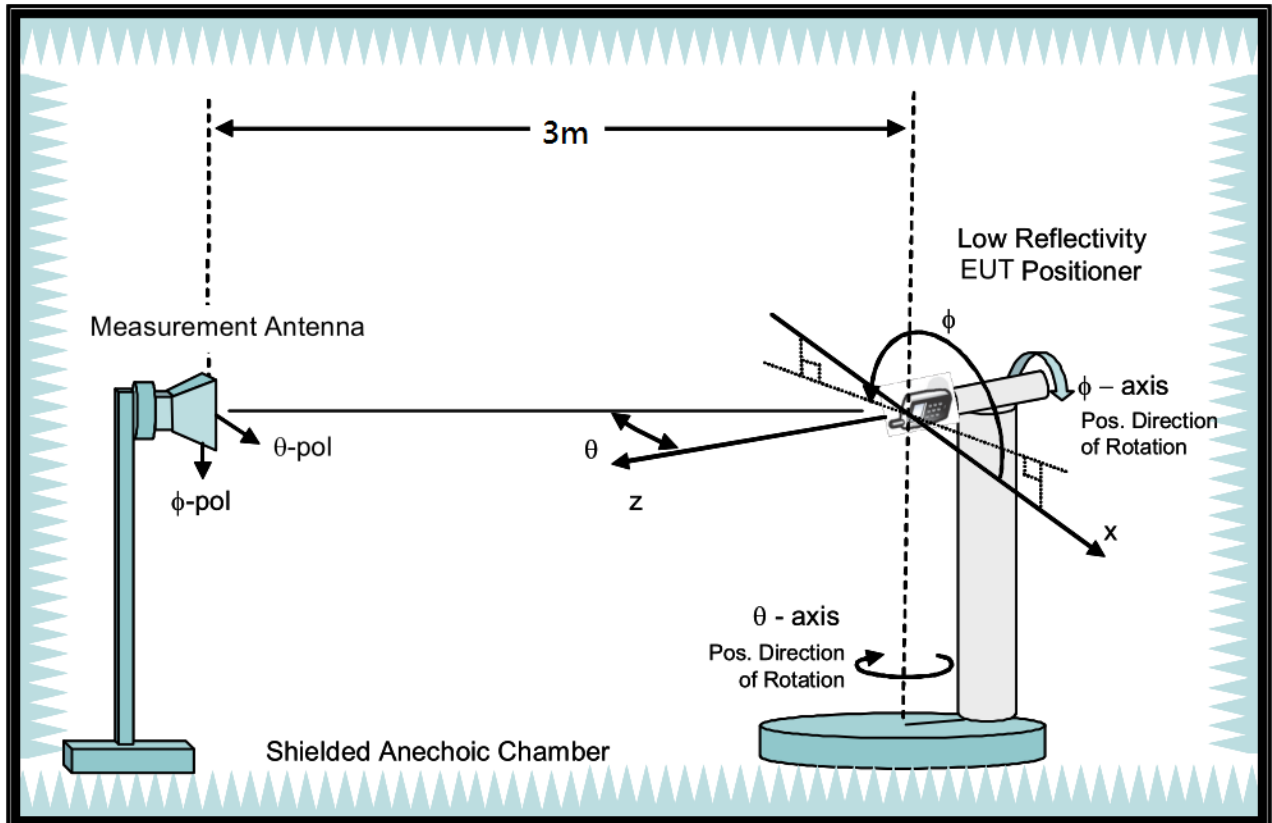
Test configuration: Reference to CITA OTA distributed-axes system configuration.

Chamber: Fully Anechoic Chamber.

Measurement antenna: Dual Polarization Horn antenna

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

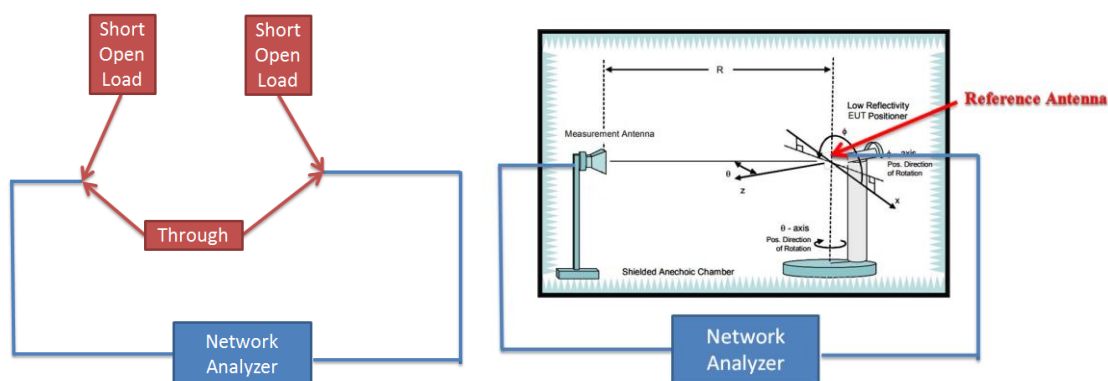
#Reference to CTIA "ctia-test-plan-for-wireless-device-over-the-air-performance-ver-3-7-1"



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 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	2400	2450	2500	5150	5200	5300	5600	5750	5800	5900	6000	6500	7000	7200
G(theta) reading (dB)	-33.48	-33.18	-32.45	-32.78	-32.43	-32.85	-32.74	-32.13	-32.46	-33.46	-32.73	-33.41	-34.78	-35.31
G(phi) reading (dB)	-33.45	-32.13	-32.74	-32.43	-32.87	-31.78	-32.46	-32.37	-32.73	-32.87	-32.46	-33.68	-34.74	-35.08
Reference gain (dBi)	10.4	10.5	10.2	11.4	11.5	11.9	12.5	11.8	11.7	11.6	11.8	11.5	11.4	10.8
Factor(theta) (dB)	43.88	43.68	42.65	44.18	43.93	44.75	45.24	43.93	44.16	45.06	44.53	44.91	46.18	46.11
Factor(phi) (dB)	43.85	42.63	42.94	43.83	44.37	43.68	44.96	44.17	44.43	44.47	44.26	45.18	46.14	45.88

Note:

$G \text{ reading (dB)} = 20 \cdot \log(V_2/V_1) = 10 \cdot \log(P_2/P_1)$

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.

Factor = gain factor + power gain conversion= (Reference antenna gain)-(G 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 7.5 degree from 0 to 352.5 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)	5.2G	5.3G	5.6G	5.785G
Ant. 1 (dBi)	3.3	-0.99	0.25	-1.19
Ant. 2 (dBi)	-8.2	2.81	2.94	2.21
Ant. 3 (dBi)	-0.56	-0.63	-0.15	0.04
Ant. 4 (dBi))	3.06	-0.21	-1.12	-2.8
DG [1SS] (dBi)	6.47	6.4	6.64	5.78
Polarization	Phi	Phi	Phi	Phi
$\Theta(^{\circ})$	90	52.5	52.5	60
$\Phi(^{\circ})$	150	352.5	7.5	337.5

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

Frequency (Hz)	6.175G	6.475G	6.695G	6.995G
Ant. 1 (dBi)	2.39	0.2	2.87	0.19
Ant. 2 (dBi)	-2.36	-2.9	0.13	-1.83
Ant. 3 (dBi)	-4.85	-8.86	-6.83	-1.85
Ant. 4 (dBi))	2.89	5.61	-0.8	3.96
DG [1SS] (dBi)	6.12	6.04	5.52	6.48
Polarization	Theta	Theta	Theta	Theta
$\Theta(^{\circ})$	105	97.5	97.5	90
$\Phi(^{\circ})$	255	337.5	300	337.5

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)	5.2G	5.3G	5.6G	5.785G
Ant. 1 [$10^{(G/20)}$]	$10^{(3.3/20)}$	$10^{(-0.99/20)}$	$10^{(0.25/20)}$	$10^{(-1.19/20)}$
Ant. 2 [$10^{(G/20)}$]	$10^{(-8.2/20)}$	$10^{(2.81/20)}$	$10^{(2.94/20)}$	$10^{(2.21/20)}$
Ant. 3 [$10^{(G/20)}$]	$10^{(-0.56/20)}$	$10^{(-0.63/20)}$	$10^{(-0.15/20)}$	$10^{(0.04/20)}$
Ant. 4 [$10^{(G/20)}$]	$10^{(3.06/20)}$	$10^{(-0.21/20)}$	$10^{(-1.12/20)}$	$10^{(-2.8/20)}$
Ant. 1 [$10^{(G/20)}$] value	1.462	0.892	1.029	0.872
Ant. 2 [$10^{(G/20)}$] value	0.389	1.382	1.403	1.29
Ant. 3 [$10^{(G/20)}$] value	0.938	0.93	0.983	1.005
Ant. 4 [$10^{(G/20)}$] value	1.422	0.976	0.879	0.724
Sum All Antenna [Amax]	4.211	4.18	4.294	3.891
DG [$10 \cdot \log(A_{max}^2/N_{ant})$]	6.47	6.4	6.64	5.78

DG_1SS max value position calculation

Frequency (Hz)	6.175G	6.475G	6.695G	6.995G
Ant. 1 [$10^{(G/20)}$]	$10^{(2.39/20)}$	$10^{(0.2/20)}$	$10^{(2.87/20)}$	$10^{(0.19/20)}$
Ant. 2 [$10^{(G/20)}$]	$10^{(-2.36/20)}$	$10^{(-2.9/20)}$	$10^{(0.13/20)}$	$10^{(-1.83/20)}$
Ant. 3 [$10^{(G/20)}$]	$10^{(-4.85/20)}$	$10^{(-8.86/20)}$	$10^{(-6.83/20)}$	$10^{(-1.85/20)}$
Ant. 4 [$10^{(G/20)}$]	$10^{(2.89/20)}$	$10^{(5.61/20)}$	$10^{(-0.8/20)}$	$10^{(3.96/20)}$
Ant. 1 [$10^{(G/20)}$] value	1.317	1.023	1.392	1.022
Ant. 2 [$10^{(G/20)}$] value	0.762	0.716	1.015	0.81
Ant. 3 [$10^{(G/20)}$] value	0.572	0.361	0.456	0.808
Ant. 4 [$10^{(G/20)}$] value	1.395	1.908	0.912	1.578
Sum All Antenna [Amax]	4.046	4.008	3.774	4.218
DG [$10 \cdot \log(A_{max}^2/N_{ant})$]	6.12	6.04	5.52	6.48

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

8. Summary of Test Result

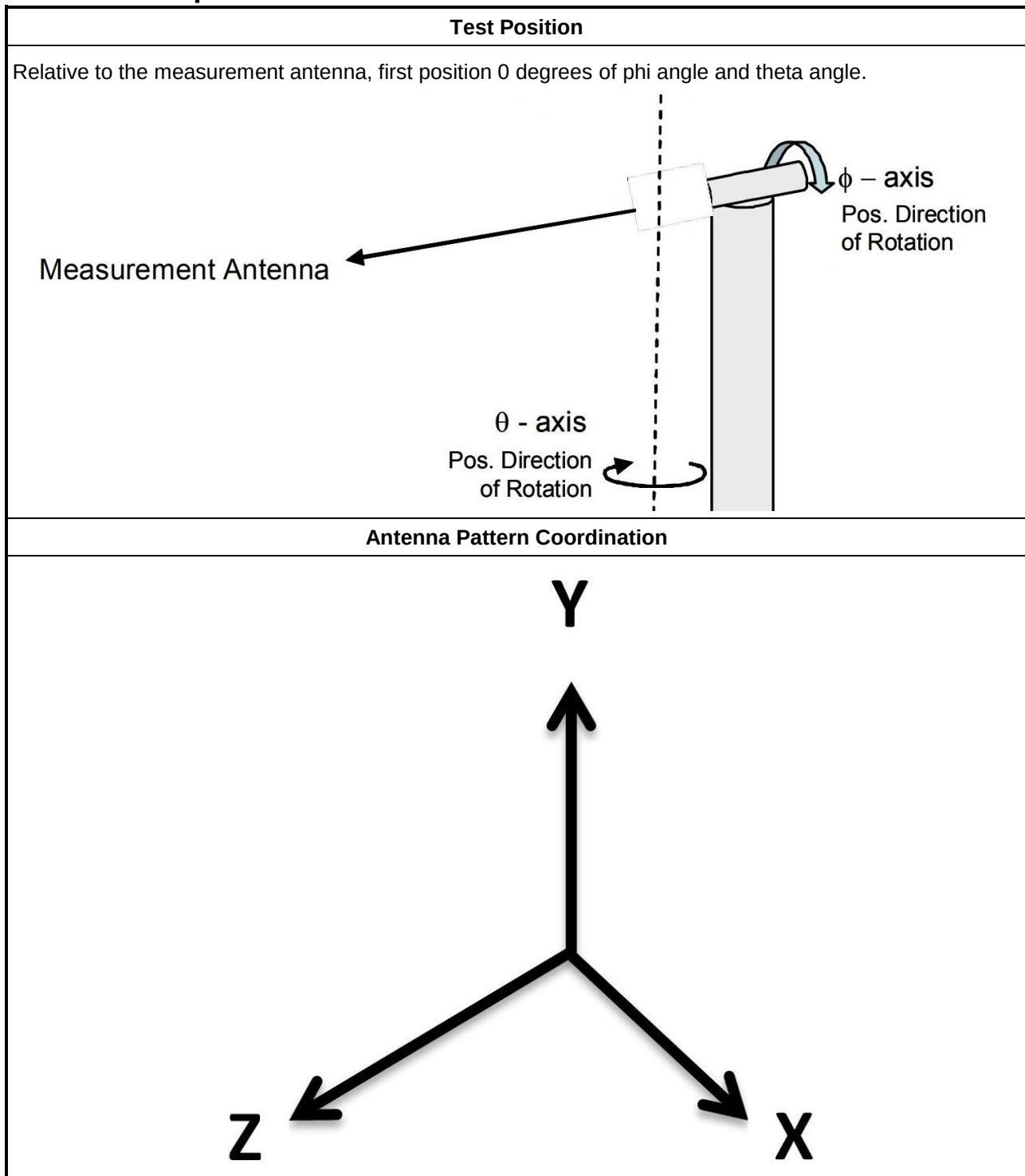
Freq(Hz)	5.2G	5.3G	5.6G	5.785G
Ant. 1 Max Gain (dBi)	3.99	3.39	3.9	3.24
Ant. 2 Max Gain (dBi)	4.89	4.71	4.62	4.55
Ant. 3 Max Gain (dBi)	4.51	4.93	4.62	4.23
Ant. 4 Max Gain (dBi)	4.39	4.6	3.97	4.4
Ant. 1 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Phi/60/150	Phi/112.5/300	Phi/105/187.5	Phi/112.5/247.5
Ant. 2 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/127.5/292.5	Theta/127.5/292.5	Theta/165/255	Theta/135/262.5
Ant. 3 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/60/255	Theta/97.5/277.5	Theta/45/262.5	Theta/90/285
Ant. 4 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Phi/97.5/300	Phi/97.5/292.5	Phi/90/60	Phi/105/60
Max Gain (dBi)	4.89	4.93	4.62	4.55
DG [1SS] (dBi)	6.47	6.4	6.64	5.78
DG [2SS] (dBi)	4.89	4.93	4.62	4.55
DG [4SS] (dBi)	4.89	4.93	4.62	4.55

Freq(Hz)	6.175G	6.475G	6.695G	6.995G
Ant. 1 Max Gain (dBi)	4.95	4.32	3.56	4.48
Ant. 2 Max Gain (dBi)	4.99	4.02	3.1	5.27
Ant. 3 Max Gain (dBi)	4.67	4.49	3.33	5.53
Ant. 4 Max Gain (dBi)	5.14	5.61	5.13	4.74
Ant. 1 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/97.5/307.5	Theta/90/307.5	Theta/90/300	Theta/97.5/315
Ant. 2 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Phi/67.5/315	Phi/90/75	Phi/97.5/300	Phi/97.5/90
Ant. 3 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Phi/105/127.5	Phi/105/120	Phi/105/112.5	Phi/97.5/105
Ant. 4 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/97.5/262.5	Theta/97.5/337.5	Theta/97.5/337.5	Theta/97.5/330
Max Gain (dBi)	5.14	5.61	5.13	5.53
DG [1SS] (dBi)	6.12	6.04	5.52	6.48
DG [2SS] (dBi)	5.14	5.61	5.13	5.53
DG [4SS] (dBi)	5.14	5.61	5.13	5.53

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. If directional gain is less than max gain, use max gain as directional gain. Refer to KDB662911D01 (F) (2) (e) (ii).
4. Directional Gain (2SS) = Directional Gain (1SS) – 3dB.
5. Directional Gain (4SS) = Directional Gain (1SS) – 6dB.

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-1531	1GHz~18GHz	Dec. 20, 2024	Dec. 19, 2025
Dual Polarization Horn Antenna	Sporton	S0209DP	S0209DP-001	2GHz~9GHz	N.C.R.	N.C.R.
ENA Series Network Analyzer	AGILENT	E5071C	MY46419477	100kHz~8.5GHz	Jul. 30, 2024	Jul. 29, 2025
VNA Calibration Kit	TS RF	TS85033E-F	-	DC~9GHz	N.C.R.	N.C.R.
Multi-axis positioner	Sporton	MAPS01	MAPS01-001	Theta / Phi axis	N.C.R.	N.C.R.
Test Software	SPORTON	SENSE-RDG	V1.0.8	-	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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————THE END————