Antenna Test Report

Equipment	:	**Antenna**
Brand Name	:	**INPAQ**
Model Name	:	**WA-F-LA-01-015**
Applicant	:	**AzureWave Technologies, Inc. 8F., No.94, Baozhong Rd. , Xindian Dist., New Taipei City , Taiwan 231**
Manufacturer	:	**INPAQ Technology Co., Ltd. No. 11, Ke-Yi St., Chunan, Miaoli 350 Taiwan R.O.C.**
Standard	:	**ANSI C63.5: 2017**

The product was received on Feb. 10, 2022, and testing was started from Feb. 17, 2022 and completed on Feb. 17, 2022. We, SPORTON INTERNATIONAL INC. Hsinhua Laboratory, would like to declare that the tested sample has been evaluated in accordance with the procedures given in ANSI C63.5: 2017 and shown compliance with the applicable technical standards.

The test results in this report apply exclusively to the tested model / sample. Without written approval of SPORTON INTERNATIONAL INC. Hsinhua Laboratory, the test report shall not be reproduced except in full.

Approved by: Jackson Tsai

SPORTON INTERNATIONAL INC. Hsinhua Laboratory
No.52, Huaya 1st Rd., Guishan Dist., Taoyuan City 333411, Taiwan (R.O.C.)

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Revision History

Report No.	Version	Description	Issued Date
AP212635	01	Initial issue of report	Mar. 17, 2022

Summary of Test Result

Report Clause	Ref Std. Clause	Test Items	Result (PASS/FAIL)	Remark
2	-	Antenna test result	PASS	-

Declaration of Conformity:
The test results with all measurement uncertainty excluded are presented in accordance with the regulation limits or requirements declared by manufacturers.
Comments and Explanations:
None.

Reviewed by: Sam Tsai

Report Producer: Anne Kuo

1 General Description

1.1 Antenna Information

Antenna Category	
☐	Equipment placed on the market without antennas
☒	Integral antenna (antenna permanently attached)
	☐ Temporary RF connector provided
	☒ No temporary RF connector provided Transmit chains bypass antenna and soldered temporary RF connector provided for connected measurement. In case of conducted measurements the transmitter shall be connected to the measuring equipment via a suitable attenuator and correct for all losses in the RF path.
☐	External antenna (dedicated antennas)

Antenna General Information						
No.	**Brand Name**	**Model Name**	**Ant. Type**	**Frequency**	**Gain (dBi)**	**Support**
1	INPAQ	WA-F-LA-01-015	PCB	2400MHz	5.66	2.4G
				2450MHz	4.99	2.4G
				2500MHz	4.71	2.4G

1.2 Support Equipment

Support Equipment				
No.	**Equipment**	**Brand Name**	**Model Name**	**Remark**
1	Signal Generator	R&S	SMB100A	Remote

1.3 Testing Applied Standards

According to the specifications of the manufacturer, the AUT must comply with the requirements of the following standards:

- ANSI C63.5: 2017

1.4 Testing Location

Test Lab.：Sporton International Inc. Hsinhua Laboratory				
☒ Hsinhua **(TAF:** 3785**)**	**ADD:** No.52, Huaya 1st Rd., Guishan Dist., Taoyuan City 333411, Taiwan (R.O.C.)			
	TEL: 886-3-327-3456		**FAX:** 886-3-327-0973	
Test Condition	**Test Site No.**	**Test Engineer**	**Test Environment**	**Test Date**
Radiated	05CH01-HY	Raven Chien	22.3~23.1°C / 56~73%	17/Feb/2022
☐ Wen 33rd.St. **(TAF:** 3785**)**	**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	

1.5 Test Channel Frequencies Configuration

Test Channel Frequency Configuration	
Test Channel Frequency	
Mode 1	2400MHz
Mode 2	2450MHz
Mode 3	2500MHz

2 Antenna Test Result

2.1 Test Procedures

2.1.1 Standard Antenna Method

Sporton implement Standard Antenna Method in electromagnetic fully anechoic chambers to measure the unknown antenna gain of AUT. To measure the gain of an antenna, three antennas are required:
a) The antenna under test (AUT)
b) An antenna of known gain, that we will call Reference Gain
c) A third antenna which can be of unknown gain

The far-field calculations are accurate when the distance, r, from an antenna of length D to a point of investigation is greater than:

Dimension *D* of radiating structure	Far-field criterion rR_{ff}
Small: low-gain antenna in free space D<λ	R_{ff} λ / 2π
Large: low-gain antenna installed on or near a large conducting ground plane with dimension D>>λ	R_{ff} 8 λ
Large (high-gain antenna) with aperture diameter D>>λ	R_{ff} $2D^2$/ λ Rayleigh distance

Two measurements are required to determine the gain of the antenna under test (AUT). In each measurement, one antenna is connected to a transmitter, which can be a Signal Generator, and the other one is connected to a receiver, which can be a Spectrum Analyzer or a Power Meter. In our case, the receiver will be a Spectrum Analyzer. The antennas are mounted over tripods at fixed positions. The distance between the tripods should be more than a couple of meters to measure the far field. It is assumed that the three antennas have been carefully matched to the appropriate impedance and accurately calibrated and matched devices are being used. The antenna with known gain may be any type of antenna, which has been calibrated either by direct measurement or in special cases by accurate construction according to computed dimensions.

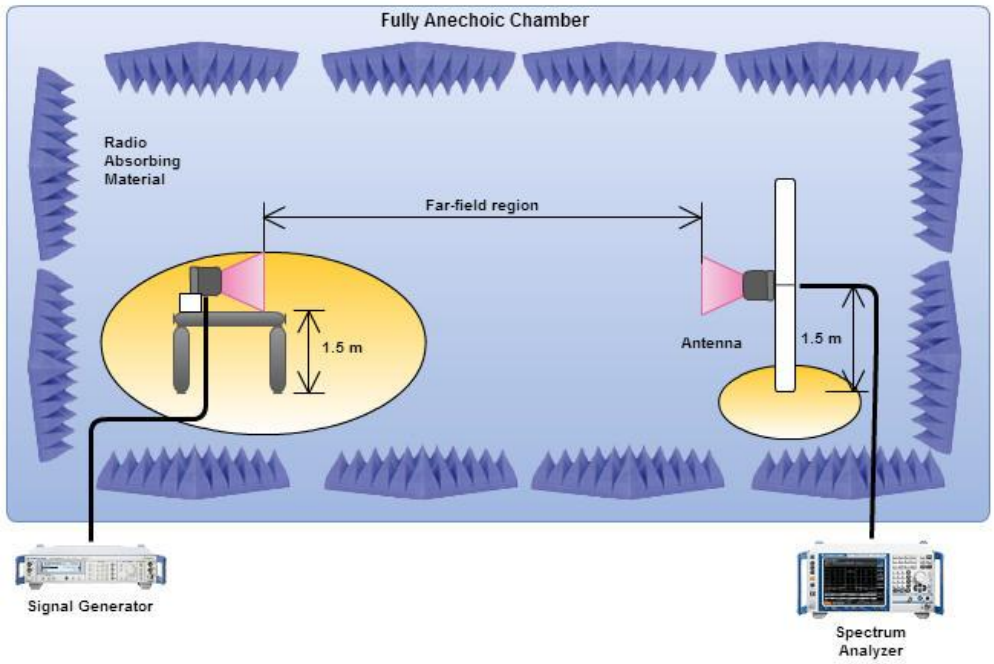
To prepare the measurement, switch on the Signal Generator and the Spectrum Analyzer well in advance and let them stabilize. Set the frequency of the Signal Generator to measurement frequency, with no modulation and disable the RF output until you connect the antenna. Set also the Spectrum Analyzer for a center frequency of measurement frequency and a frequency span of 1 MHz.

In the first measurement, the antenna of known gain is connected to the transmitter and the third antenna is connected to the receiver. Switch on the RF output of the Signal Generator and set its level high enough so that on the Spectrum Analyzer you can see the peak of the signal well over the noise floor. After arranging the two antennas to read the maximum value for the received signal, record this value on paper. This will be your Reference Level.

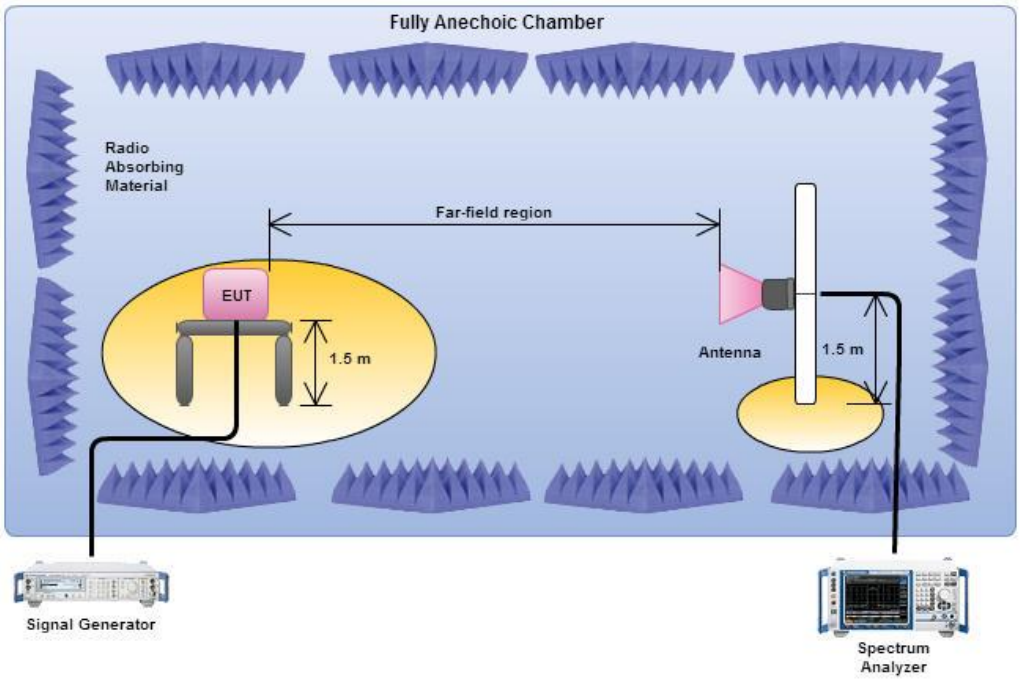
Without changing the position of the tripods nor the cables or connector/adapters, you should now exchange the antenna of known gain with the antenna under test. The value of the received signal must be read and recorded on paper as Measured Level. The gain of the antenna under test is then given by:
Gain (dBi)= Reference Gain+(Measured Level - Reference Level)
The gains are expressed in dBi and the levels are expressed in dBm.

2.1.2 Test Setup

Standard Know Gain Antenna – Read Reference Level in Spectrum



AUT Unknown Gain Antenna – Read Measured Level in Spectrum



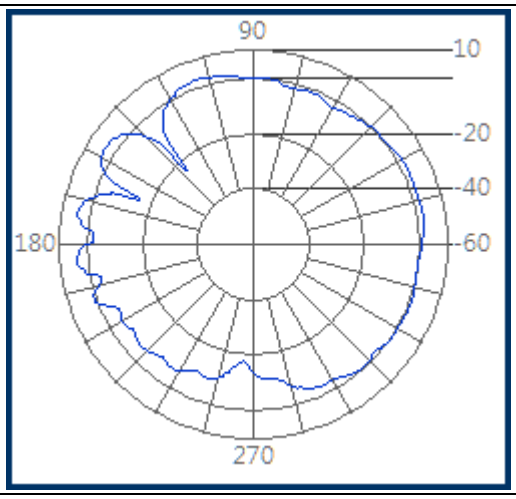
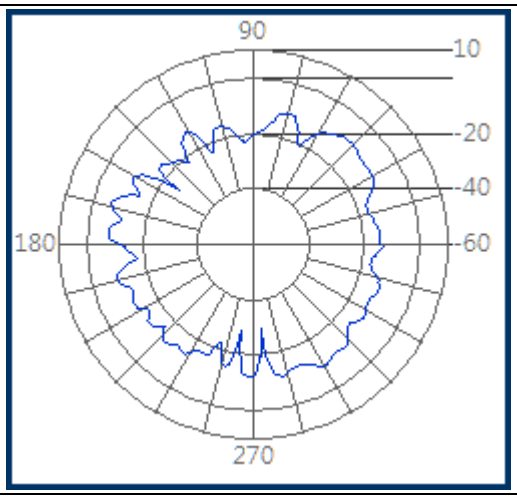
2.1.3 Test Result of Antenna Gain

X Axis				
Test Freq	**Peak Gain (dBi)**	**Average Gain (dBi)**	**Beamwidth (°)**	**Plane**
2400MHz	PK 4.25 dBi	AV -0.75 dBi	Beam 185 °	Azimuth_Co_plane_B
2450MHz	PK 3.14 dBi	AV -1.25 dBi	Beam 360 °	Azimuth_Co_plane_M
2500MHz	PK 3.33 dBi	AV -1.83 dBi	Beam 341 °	Azimuth_Co_plane_T
2400MHz	PK -6.85 dBi	AV -13.08 dBi	Beam 261 °	Elevation_Co_plane_B
2450MHz	PK -5.22 dBi	AV -11.63 dBi	Beam 173 °	Elevation_Co_plane_M
2500MHz	PK -6.43 dBi	AV -13.29 dBi	Beam 32 °	Elevation_Co_plane_T

Y Axis				
Test Freq	**Peak Gain (dBi)**	**Average Gain (dBi)**	**Beamwidth (°)**	**Plane**
2400MHz	PK 2.32 dBi	AV -5.44 dBi	Beam 60 °	Azimuth_Co_plane_B
2450MHz	PK 2.29 dBi	AV -4.66 dBi	Beam 74 °	Azimuth_Co_plane_M
2500MHz	PK 1.32 dBi	AV -6.36 dBi	Beam 60 °	Azimuth_Co_plane_T
2400MHz	PK 2.79 dBi	AV -0.25 dBi	Beam 360 °	Elevation_Co_plane_B
2450MHz	PK 2.82 dBi	AV -0.2 dBi	Beam 360 °	Elevation_Co_plane_M
2500MHz	PK 1.8 dBi	AV -0.64 dBi	Beam 360 °	Elevation_Co_plane_T

Z Axis				
Test Freq	**Peak Gain (dBi)**	**Average Gain (dBi)**	**Beamwidth (°)**	**Plane**
2400MHz	PK 5.66 dBi	AV -1.71 dBi	Beam 47 °	Azimuth_Co_plane_B
2450MHz	PK 4.99 dBi	AV -1.74 dBi	Beam 195 °	Azimuth_Co_plane_M
2500MHz	PK 4.71 dBi	AV -1.86 dBi	Beam 50 °	Azimuth_Co_plane_T
2400MHz	PK -4.6 dBi	AV -12.23 dBi	Beam 81 °	Elevation_Co_plane_B
2450MHz	PK -5.12 dBi	AV -12.52 dBi	Beam 76 °	Elevation_Co_plane_M
2500MHz	PK -6.3 dBi	AV -13.46 dBi	Beam 80 °	Elevation_Co_plane_T

2.1.4 Test Result of Antenna Gain Pattern

2.4G X Axis	
B – Azimuth Plane – Co-polar	B – Elevation Plane – Co-polar
	
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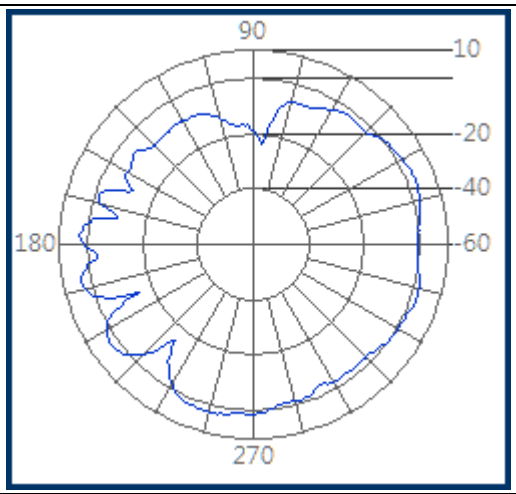	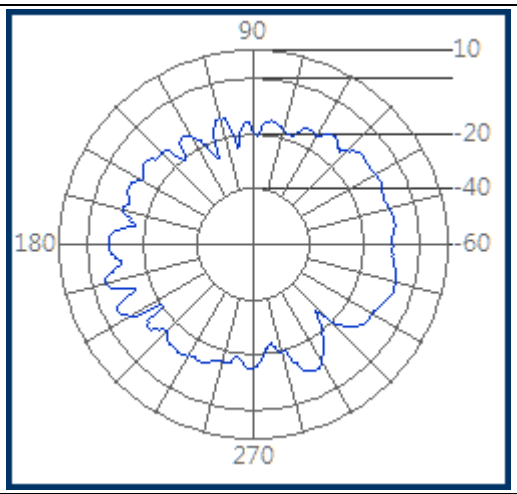
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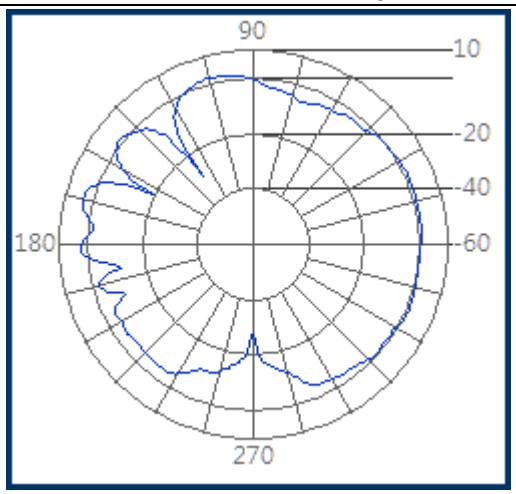	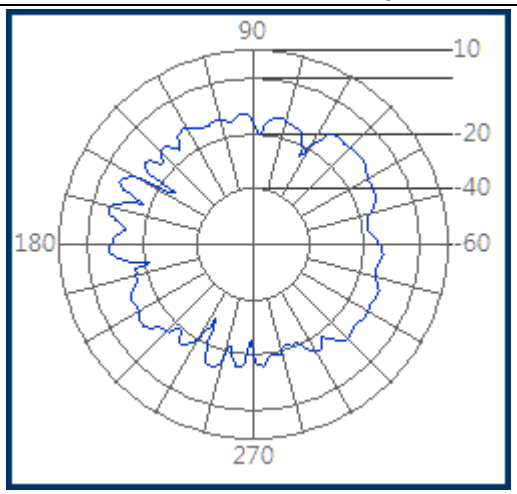

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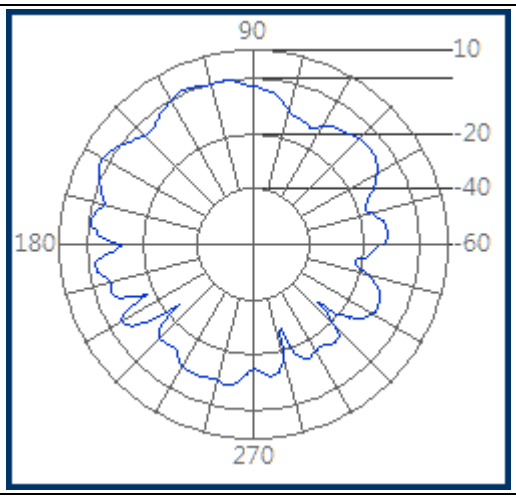
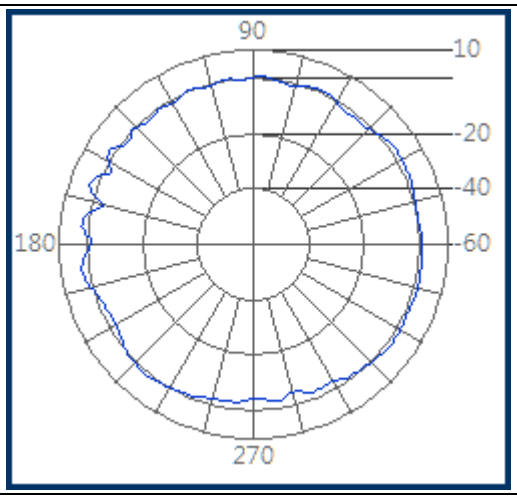
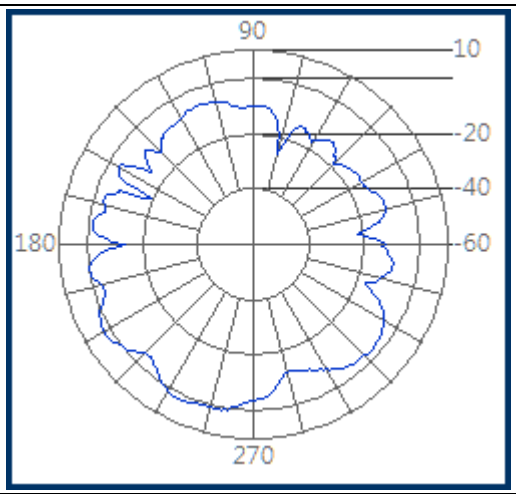
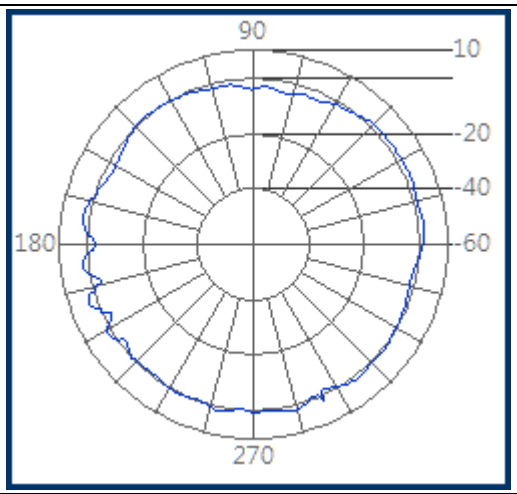
B – Azimuth Plane – Co-polar	B – Elevation Plane – Co-polar
	
M – Azimuth Plane – Co-polar	M – Elevation Plane – Co-polar
	
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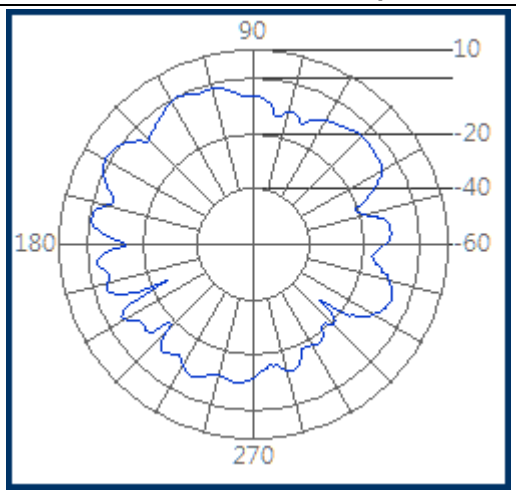
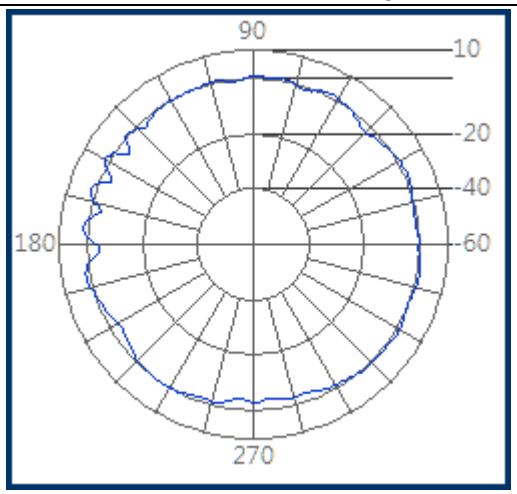
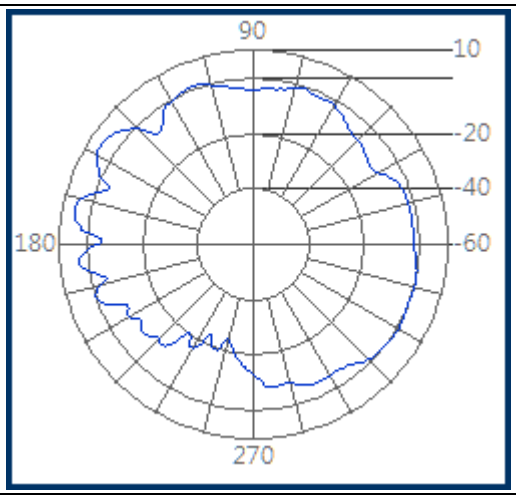
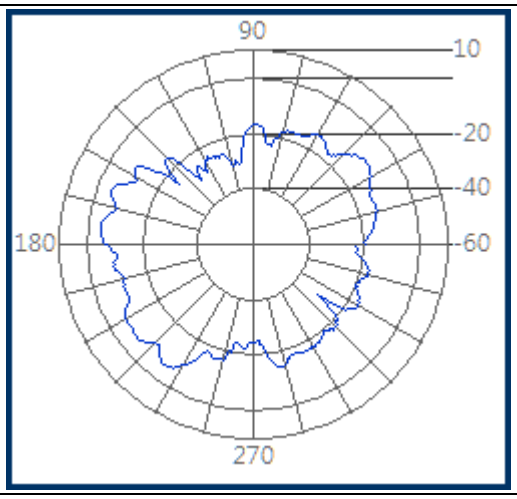
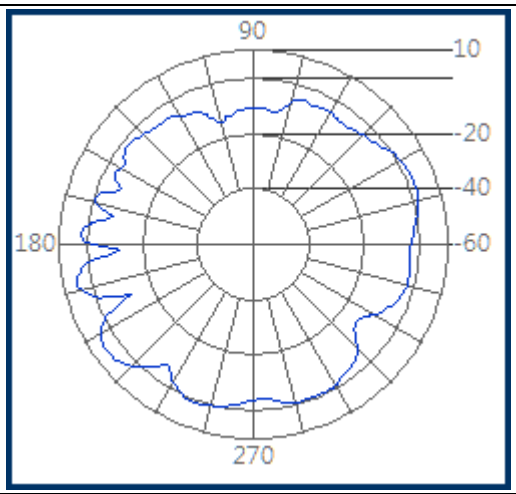
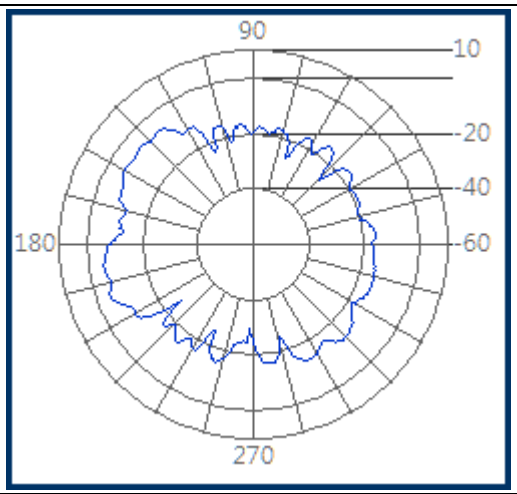
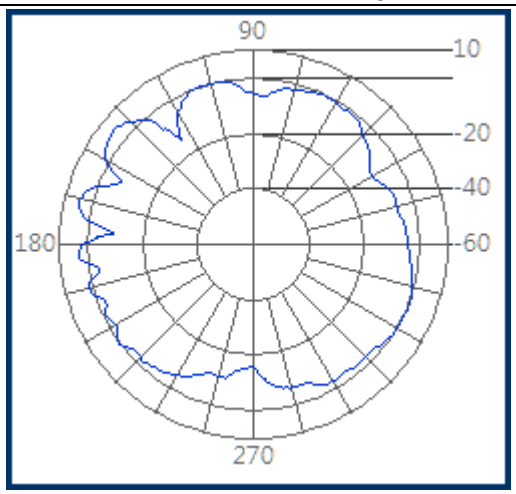
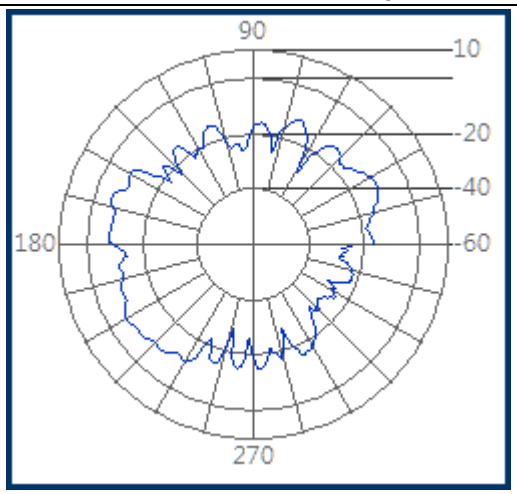
	

2.4G Z Axis	
B – Azimuth Plane – Co-polar	B – Elevation Plane – Co-polar
	
M – Azimuth Plane – Co-polar	M – Elevation Plane – Co-polar
	
T – Azimuth Plane – Co-polar	T – Elevation Plane – Co-polar
	

3 Test Equipment and Calibration Data

Instrument	Manufacturer /Brand	Model No.	Serial No.	Characteristics	Calibration Date	Calibration Due Date
Spectrum Analyzer	R&S	FSV40	101504	10kHz - 40GHz	30/Apr/2021	29/Apr/2022
Signal Generator	R&S	SMB100A	181147	100kHz~40GHz	21/Oct/2021	20/Oct/2022
Double Ridged Guide Horn Antenna	ETS.LINDGREN	3117	91920	1GHz~18GHz	25/Nov/2021	24/Nov/2022
Horn Antenna	COM-POWER	AHA-118	10091	1GHz~18GHz	23/Jun/2021	22/Jun/2022

4 Uncertainty of Evaluation

Essential Antenna Test Suites		
Description	**Measuring Uncertainty (confidence of 95%)**	**Standard Required Measuring Uncertainty**
Radiation Pattern Envelope (RPE)	± 2.6 dB	N/A
Antenna Gain	± 3.1 dB	N/A