Test report

REP026818-9TRFEMC

Date of issue: March 30, 2024

Applicant:

Murphy's Bowl LLC

Product:

Wireless Information Station

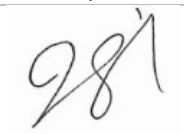
Model:	Variant(s):
IDAP v1.0	None

Specifications:

- 2D Antenna Pattern and Peak Gain

Lab and test locations

Company name	Nemko USA Inc.
Address	2210 Faraday Ave, Suite 150
City	Carlsbad
State	California
Postal code	92008
Country	USA
Telephone	+1 760 444 3500
Website	www.nemko.com
FCC Site Number	Test Firm Registration Number: 392943; Designation Number: US5058
ISED Test Site	2040B-3

Tested by	Chenhao Ma, Wireless Test Technician
Reviewed by	James Cunningham, EMC/WL Manager
Review date	March 30, 2024
Reviewer signature	

Limits of responsibility

Note that the results contained in this report relate only to the items tested and were obtained in the period between the date of initial receipt of samples and the date of issue of the report.
This test report has been completed in accordance with the requirements of ISO/IEC 17025.

Copyright notification

Table of Contents

Section 1 Report summary

1.1 Test specifications

None	2D antenna pattern and peak gain

1.2 Exclusions

None.

1.3 Statement of compliance

See “Section 2 Summary of test results” for full details.

1.4 Test report revision history

Table 1.4-1: *Test report revision history*

Revision #	Issue Date	Details of changes made to test report
REP026818-9TRFEMC	March 30, 2024	Original report issued

Section 2 Summary of test results

2.1 Sample information

Receipt date	06-Feb-24
Nemko sample ID number	REP026818

2.2 Testing period

Test start date	05-Mar-24
Test end date	06-Mar-24

2.3 Test results

Table 2.3-1: *Summary of results*

Test description	Verdict
2D antenna pattern	Tested
Peak gain	Tested

Section 3 Equipment (antenna) under test (EUT) details

3.1 Disclaimer

This section contains information provided by the applicant and has been utilized to support the test plan. Inaccurate information provided by the applicant can affect the validity of the results within this test report. Nemko accepts no responsibility for the information contained within this section and the impact it may have on the test plan and resulting measurements.

3.2 Applicant

Company name	Murphy's Bowl LLC
Address	10400 NE 4th Street, Suite 3600,
City	Bellevue
State	WA
Postal/Zip code	98004
Country	Unites States

3.3 Manufacturer

Company name	Schippers and Crew, Inc.
Address	5309 Shilshole Ave NW, Suite 100
City	Seattle
State	WA
Postal/Zip code	98107
Country	United States

3.4 EUT information

Product name	Wireless Information Station
Model	IDAP v1.0
Variant(s)	None
Serial number	None
Part number	None
Power requirements	48v DC or PoE
Description/theory of operation	None
Operational frequencies	2402MHz, 2440MHz, 2480MHz
Software details	None

3.5 Antenna information

Part number	None
Description	None
Manufacturer	Schippers and Crew, Inc.

3.6 EUT setup details

Table 3.6-1: *EUT sub assemblies*

Description	Brand name	Model/Part number	Serial number	Rev.
None	None	None	None	None

Table 3.6-2: *EUT interface ports*

Description	Qty.
USB	2
Ethernet	3
Power	1

Table 3.6-3: *Support equipment*

Description	Brand name	Model/Part number	Serial number	Rev.
Laptop	HP	Latitude 5420	None	None
Network switch	Netgear	MS108EUP	6R52285WA0057	None

Table 3.6-4: *Inter-connection cables*

Cable description	From	To	Length (m)
Ethernet cable	Network switch	EUT	4m

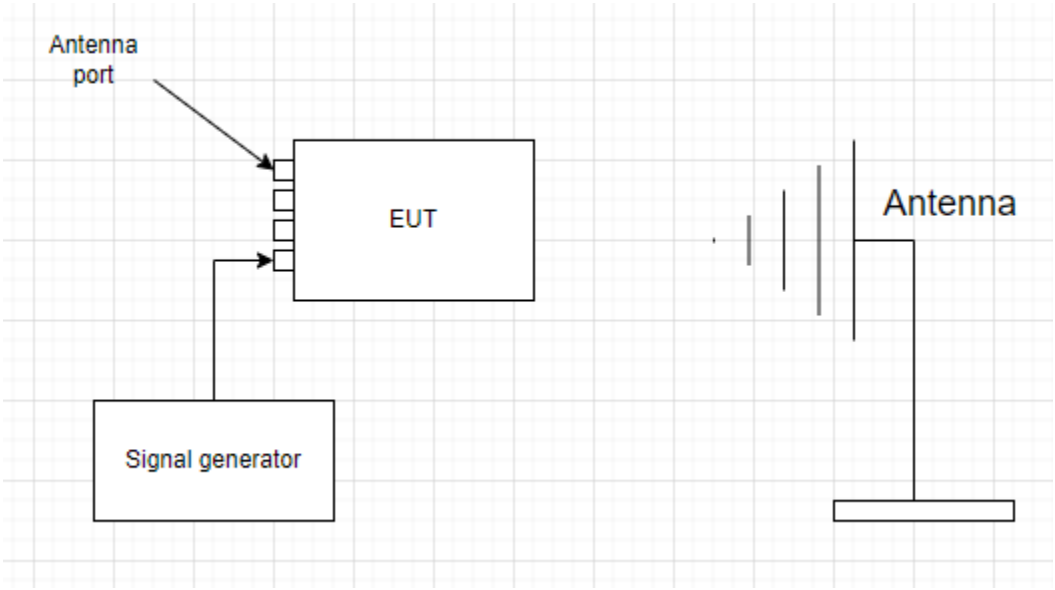


Figure 3.6-1: Test setup diagram

Section 4 Engineering considerations

4.1 Modifications incorporated in the EUT

None.

4.2 Technical judgement

None.

4.3 Deviations from laboratory test procedures

None.

Section 5 Test conditions

5.1 Atmospheric conditions

Temperature	15–30 °C
Relative humidity	20–75 %
Air pressure	86–106 kPa

When it is impracticable to carry out tests under these conditions, a note to this effect stating the ambient temperature and relative humidity during the tests shall be recorded and stated.

5.2 Power supply range

The normal test voltage for equipment to be connected to the mains shall be the nominal mains voltage. For the purpose of the present document, the nominal voltage shall be the declared voltage, or any of the declared voltages ±5 %, for which the equipment was designed.

Section 6 Measurement uncertainty

6.1 Uncertainty of measurement

Nemko USA Inc. has calculated measurement uncertainty and is documented in EMC/MUC/001 "Uncertainty in EMC measurements." Measurement uncertainty was calculated using the methods described in CISPR 16-4-2 Specification for radio disturbance and immunity measuring apparatus and methods – Part 4-2: Uncertainties, statistics, and limit modelling – Measurement instrumentation uncertainty. The expression of Uncertainty in EMC testing. Measurement uncertainty calculations assume a coverage factor of K=2 with 95% certainty.

Table 6.1-1: *Measurement uncertainty calculations*

Measurement		U_{cispr} **dB**	U_{lab} **dB**
Conducted disturbance at AC mains and other port power using a V-AMN	9 kHz to 150 kHz	3.8	2.9
	150 kHz to 30 MHz	3.4	2.3
Conducted disturbance at telecommunication port using AAN	150 kHz to 30 MHz	5.0	4.3
Conducted disturbance at telecommunication port using CVP	150 kHz to 30 MHz	3.9	2.9
Conducted disturbance at telecommunication port using CP	150 kHz to 30 MHz	2.9	1.4
Conducted disturbance at telecommunication port using CP and CVP	150 kHz to 30 MHz	4.0	3.1
Radiated disturbance (electric field strength in a SAC)	30 MHz to 1 GHz	6.3	5.5
Radiated disturbance (electric field strength in a FAR)	1 GHz to 6 GHz	5.2	4.7
Radiated disturbance (electric field strength in a FAR)	6 GHz to 18 GHz	5.5	5.0

Notes: Compliance assessment:

If U_{lab} is less than or equal to U_{cispr} then:

- compliance is deemed to occur is no measured disturbance level exceeds the disturbance limit;
- non-compliance is deemed to occur if any measured disturbance level exceeds the disturbance limit

If U_{lab} is greater than U_{cispr} then:

- compliance is deemed to occur is no measured disturbance level, increased by (U_{lab} - U_{cispr}), exceeds the disturbance limit;
- non-compliance is deemed to occur if any measured disturbance level, increased by (U_{lab} - U_{cispr}), exceeds the disturbance limit

V-AMN: V type artificial mains network
AAN: Asymmetric artificial network
CP: Current probe
CVP: Capacitive voltage probe
SAC: Semi-anechoic chamber
FAR: Fully anechoic room

Section 7 Testing data

7.1 2D antenna pattern and peak gain

7.1.1 References and limits

- FCC 47 CFR Part 15, Subpart B: §15.203

7.1.2 Test summary

Verdict	Pass		
Test date	March 6, 2024	Temperature	22 °C
Test engineer	Chenhao Ma, Wireless Test Technician	Air pressure	1003.4 mbar
Test location	☐ 10m semi anechoic chamber ☒ 3m semi anechoic chamber ☐ Other:	Relative humidity	57 %

7.1.3 Notes

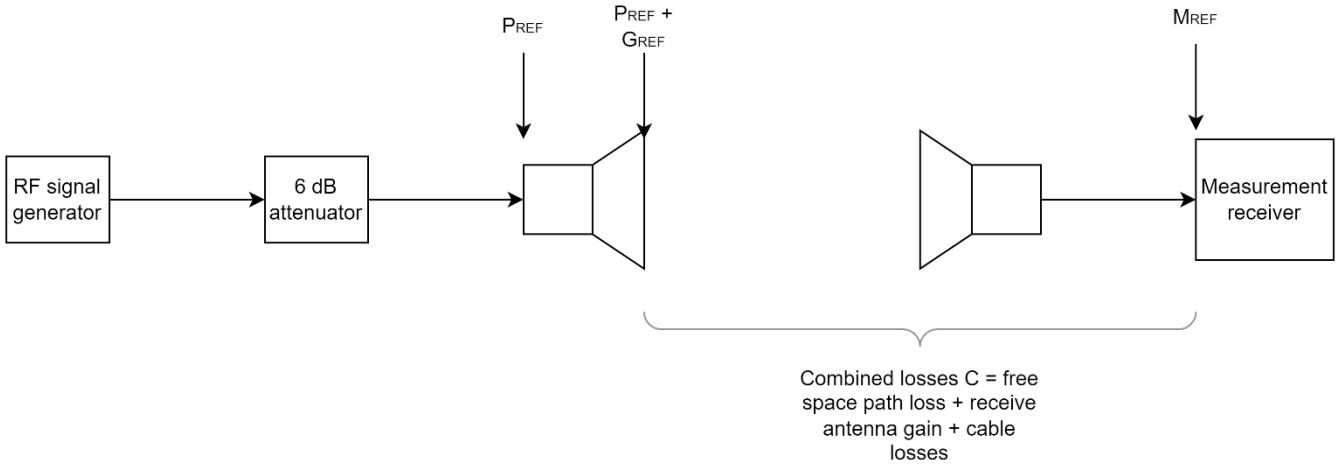
None

7.1.4 Setup details

Measurements were performed in a 3m semi-anechoic chamber and consisted of 2 steps.

Step 1: Reference Measurement:

A reference antenna is connected to an RF signal generator via a ferrite-loaded cable and 6 dB attenuator. The reference antenna is then placed at the center of the anechoic chamber turntable at a height of approximately 1.5 m. The RF signal generator is then configured to generate a 0 dB unmodulated signal at the frequency(-ies) under test. The polarization of the receive antenna is adjusted to match the polarization of the transmit antenna and the turntable angle and receive antenna height are adjusted to maximize the received signal level at the measurement receiver.

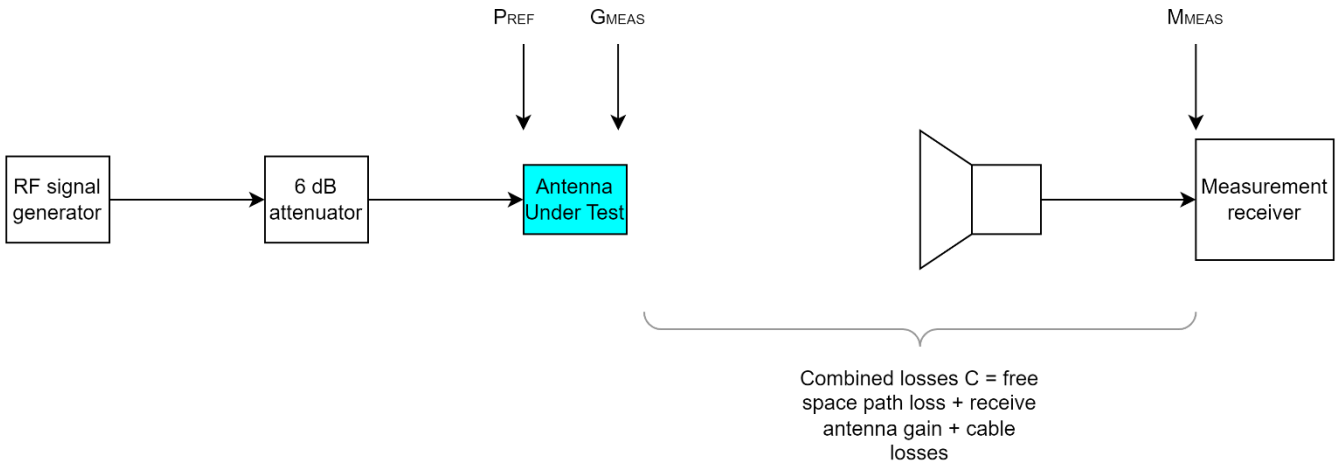


The signal level at the measurement receiver, M_{REF}, is recorded for each of the frequencies under test. Given that the transmit antenna is calibrated with a known gain G_{REF}, the following expression holds true:

$$M_{REF} = P_{REF} + G_{REF} + C \qquad \text{Equation [1]}$$

Step 2: Antenna Under Test Measurement

For this step, the reference antenna is replaced with the antenna under test. Again, the RF signal generator is set to 0 dBm output at the frequency(-ies) under test. The received signal level at the measurement receiver is recorded as the antenna under test is rotated 360 degrees in 5 degree steps. The receive antenna is then changed to the opposite polarization and the received signal level at the measurement receiver is recorded again as the turntable is rotated 360 degrees in 5 degree steps.



The peak received signal level at the measurement receiver is identified and noted as M_{MEAS}.

As before, the following holds true:

$$M_{MEAS} = P_{REF} + G_{MEAS} + C \qquad \text{Equation [2]}$$

G_{MEAS} is the peak gain of the antenna under test and is the value of interest.

Re-arranging Equation [2] in terms of G_{MEAS} gives:

$$G_{MEAS} = M_{MEAS} - P_{REF} - C \qquad \text{Equation [3]}$$

And re-arranging Equation [1] in terms of P_{REF} gives:

$$P_{REF} = M_{REF} - G_{REF} - C \qquad \text{Equation [4]}$$

Substituting P_{REF} in Equation [3] with Equation [4] gives:

$$G_{MEAS} = M_{MEAS} - (M_{REF} - G_{REF} - C) - C$$
$$G_{MEAS} = M_{MEAS} - M_{REF} + G_{REF} + C - C$$

$$\boldsymbol{G_{MEAS} = M_{MEAS} - M_{REF} + G_{REF}} \qquad \textbf{Equation [5]}$$

Where:

G_{MEAS} = peak gain of antenna under test in dBi
M_{MEAS} = measured received signal level with antenna under test
M_{REF} = measured received signa level with calibrated reference antenna
G_{REF} = gain of reference antenna in dBi

Table 7.1-1: *2D antenna pattern and peak gain equipment list*

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
EMI Test Receiver	Rohde & Schwarz	ESU40	E1121	08-23-2023	08-23-2024
Standard Gain Horn Antenna	Eravant	SAZ-2410-42-S1	EW107	12-05-2023	12-05-2024
DRG Horn	ETS-Lindgren	3117-PA	E1160	03-13-2023	03-13-2024
Antenna Horn	EMCO	3115	1033	11-03-2022	11-04-2024

Notes: N/A – not applicable
NCR – no calibration required
VOU – verify on use

Table 7.1-2: *2D antenna pattern and peak gain test software details*

Manufacturer of Software	Details
Rohde & Schwarz	EMC 32 V10.60.15

Notes: None

7.1.5 Test data

Table 7.1-3: *2D antenna pattern and peak gain results antenna port1*

Frequency (MHz)	Peak Gain (dBi)
2402 MHz	-6.99
2440 MHz	-3.53
2480 MHz	-2.10

Sample calculation:
Frequency: 2402 MHz
M_{MEAS}: -24.43 dBi
M_{REF}: -18.74 dBi
G_{REF}: 9.577 dBi
Note: The peak gain is in horizontal polarization
G_{MEAS} = $M_{MEAS} – M_{REF} + G_{REF}$
= (-25.29) – (-24.43) + (9.577)
= -6.99 dBi

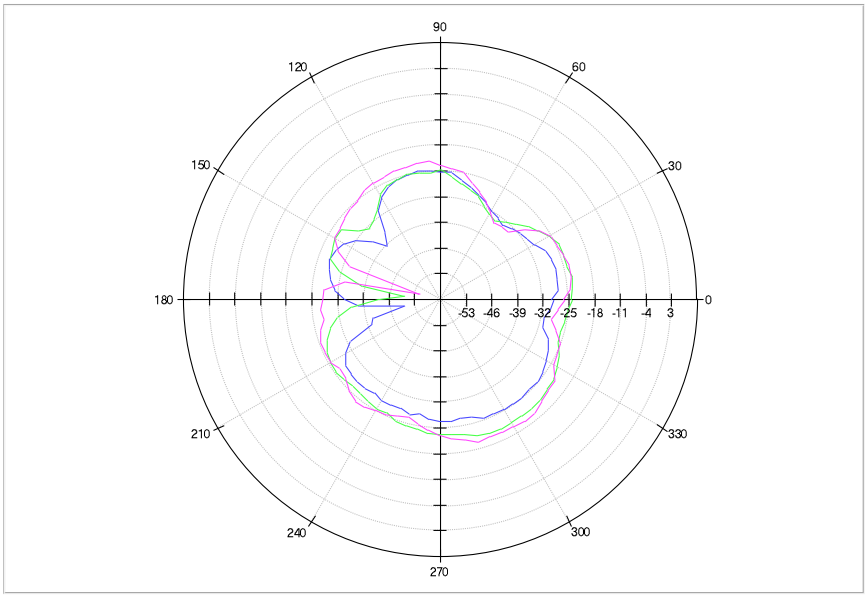


Figure 7.1-1: *2D antenna pattern, horizontal polarization*

Azimuth Chart: Vertical

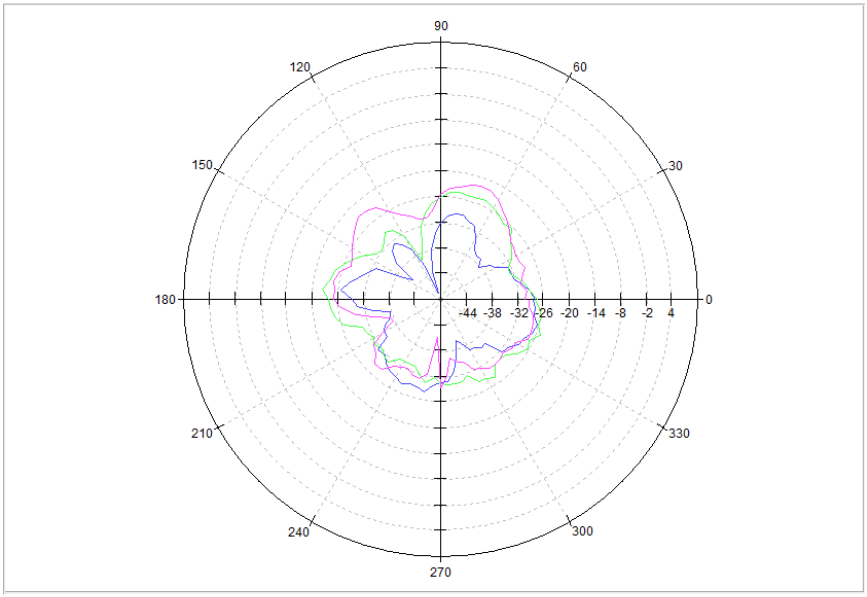


Figure 7.1-2: *2D antenna pattern, vertical polarization*

Table 7.1-4: *2D antenna pattern and peak gain results antenna port2*

Frequency (MHz)	Peak Gain (dBi)
2402 MHz	-2.60
2440 MHz	0.65
2480 MHz	-0.20

Azimuth Chart: Horizontal

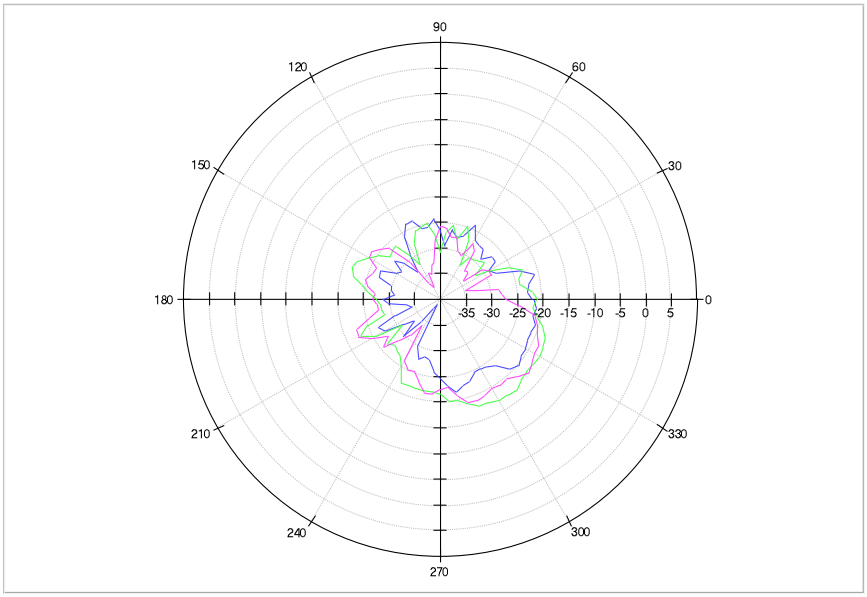


Figure 7.1-3: *2D antenna pattern, horizontal polarization*

Azimuth Chart: Vertical

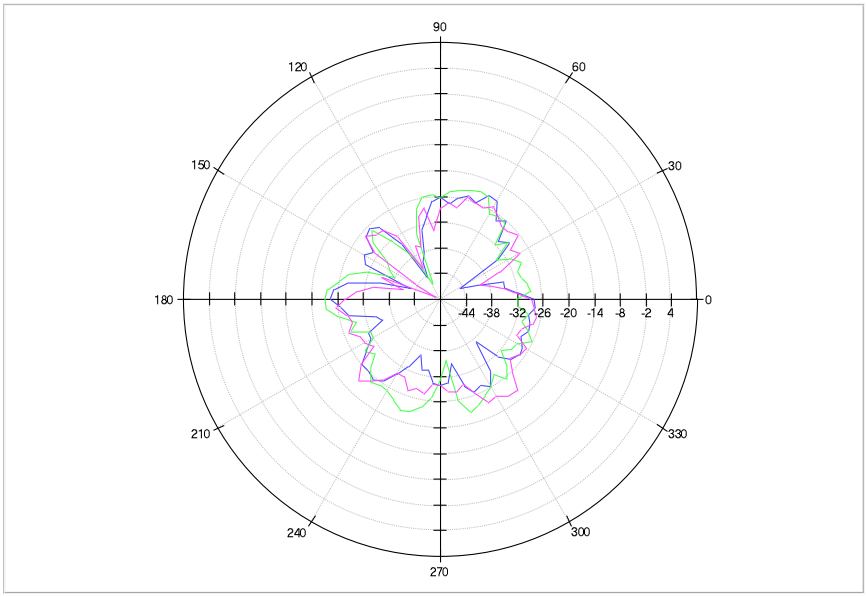


Figure 7.1-4: *2D antenna pattern, vertical polarization*

Table 7.1-5: *2D antenna pattern and peak gain results antenna port3*

Frequency (MHz)	Peak Gain (dBi)
2402 MHz	-13.69
2440 MHz	-10.26
2480 MHz	-7.75

Azimuth Chart: Horizontal

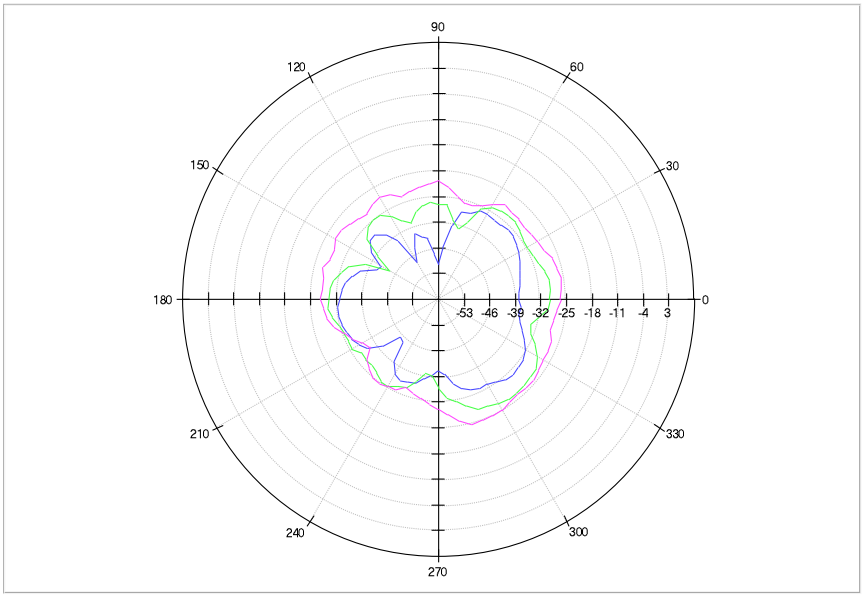


Figure 7.1-5: *2D antenna pattern, horizontal polarization*

Azimuth Chart: Vertical

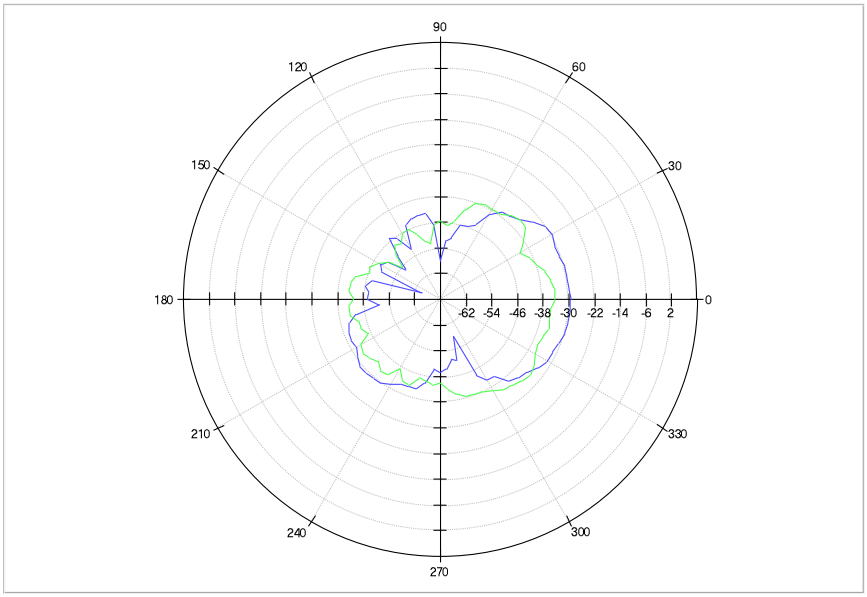


Figure 7.1-6: *2D antenna pattern, vertical polarization*

End of test report