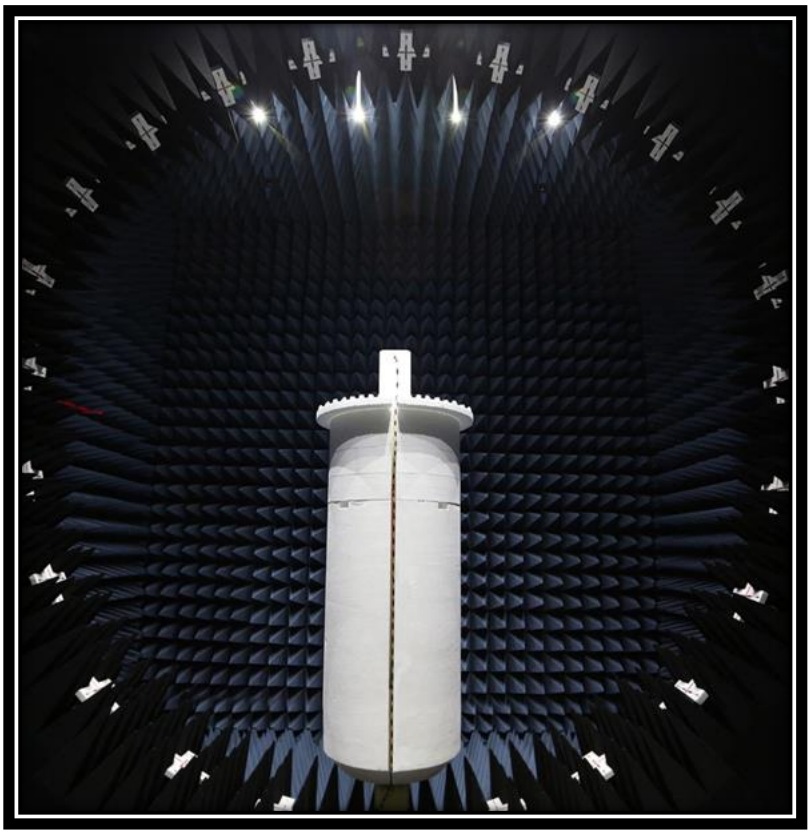
Nelson Irrigation Corporation

TWIG V UNO

Antenna Pattern Measurements

Report: NELS0019.4 Rev. 0, Issue Date: March 18, 2024



Approved by:

Johnny Candelas, Operations Manager

TABLE OF CONTENTS

element
2023.04.17

Section	Page Number

REVISION HISTORY

Revision Number	Description	Date (yyyy-mm-dd)	Page Number
00	None		

ACCREDITATIONS AND AUTHORIZATIONS

element
2021.09.01

United States

FCC - Designated by the FCC as a Telecommunications Certification Body (TCB). Certification chambers, Open Area Test Sites, and conducted measurement facilities are listed with the FCC.

A2LA - Each laboratory is accredited by A2LA to ISO / IEC 17025, and as a product certifier to ISO / IEC 17065 which allows Element to certify transmitters to FCC and IC specifications.

Canada

ISED - Recognized by Innovation, Science and Economic Development Canada as a Certification Body (CB) and as a CAB for the acceptance of test data.

European Union

European Commission – Recognized as an EU Notified Body validated for the EMCD and RED Directives.

United Kingdom

BEIS – Recognized by the UK as an Approved Body under the UK Radio Equipment and UK EMC Regulations.

Australia/New Zealand

ACMA - Recognized by ACMA as a CAB for the acceptance of test data.

Korea

MSIT / RRA - Recognized by KCC's RRA as a CAB for the acceptance of test data.

Japan

VCCI - Associate Member of the VCCI. Conducted and radiated measurement facilities are registered.

Taiwan

BSMI – Recognized by BSMI as a CAB for the acceptance of test data.

NCC - Recognized by NCC as a CAB for the acceptance of test data.

Singapore

IDA – Recognized by IDA as a CAB for the acceptance of test data.

Israel

MOC – Recognized by MOC as a CAB for the acceptance of test data.

Hong Kong

OFCA – Recognized by OFCA as a CAB for the acceptance of test data.

Vietnam

MIC – Recognized by MIC as a CAB for the acceptance of test data.

SCOPE

For details on the Scopes of our Accreditations, please visit:

California Minnesota Oregon Texas Washington

FACILITIES

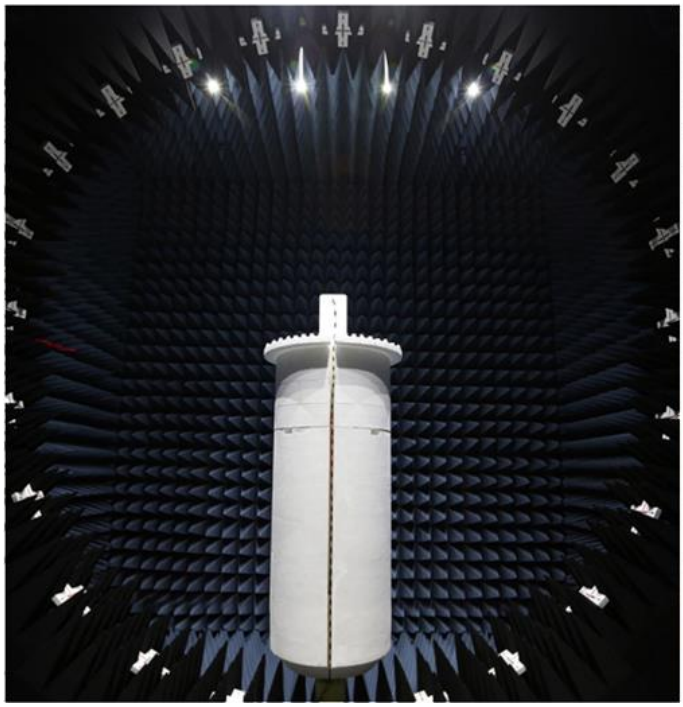
element
2023.09.21

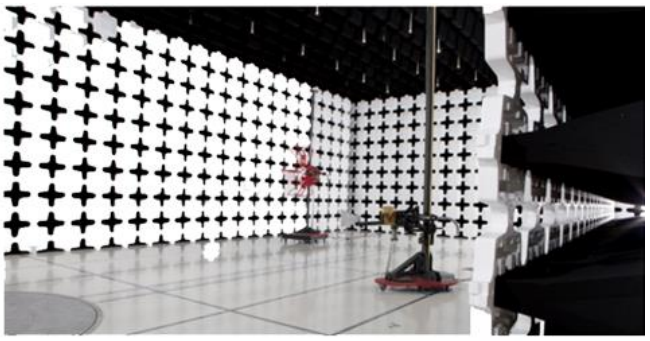
Testing was performed at the following location(s)

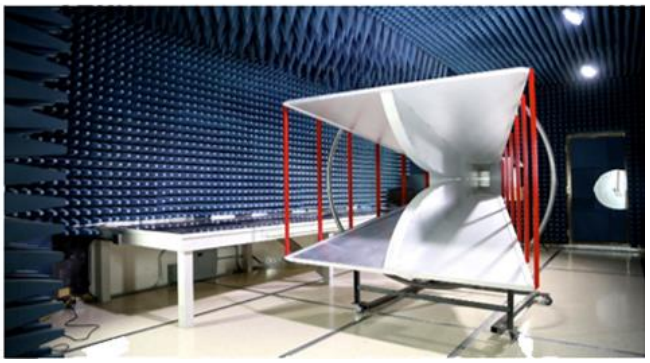
	Location	Labs (1)	Address	A2LA (2)	ISED (3)	BSMI (4)	VCCI (5)	CAB (6)	FDA (7)
☐	California	OC01-17	41 Tesla Irvine, CA 92618 (949) 861-8918	3310.04	2834B	SL2-IN-E-1154R	A-0029	US0158	TL-55
☐	Minnesota	MN01-11	9349 W Broadway Ave. Brooklyn Park, MN 55445 (612) 638-5136	3310.05	2834E	SL2-IN-E-1152R	A-0109	US0175	TL-57
☒	Oregon	EV01-12	6775 NE Evergreen Pkwy #400 Hillsboro, OR 97124 (503) 844-4066	3310.02	2834D	SL2-IN-E-1017	A-0108	US0017	TL-56
☐	Texas	TX01-09	3801 E Plano Pkwy Plano, TX 75074 (469) 304-5255	3310.03	2834G	SL2-IN-E-1158R	A-0201	US0191	TL-54
☐	Washington	NC01-05	19201 120th Ave NE Bothell, WA 98011 (425) 984-6600	3310.06	2834F	SL2-IN-E-1153R	A-0110	US0157	TL-67
☐	Offsite	N/A	See Product Description	N/A	N/A	N/A	N/A	N/A	N/A

See data sheets for specific labs

(1) The lab designations denote individual rooms within each location. (OC01, OC02, OC03, etc.)
(2) A2LA Certificate No.
(3) ISED Company No.
(4) BSMI No.
(5) VCCI Site Filing No.
(6) CAB Identifier. Recognized Phase I CAB for ISED, ACMA, BSMI, IDA, KCC/RRA, MIC, MOC, NCC, OFCA
(7) FDA ASCA No.







PRODUCT DESCRIPTION

Client and Equipment under Test (EUT) Information

Company Name:	Nelson Irrigation Corporation
Address:	848 Airport Road
City, State, Zip:	Walla Walla, WA 99362-2271
Test Requested By:	Mark Bauman
EUT:	TWIG V UNO
First Date of Test:	July 26, 2023
Last Date of Test:	July 26, 2023
Receipt Date of Samples:	July 26, 2023
Equipment Design Stage:	Production
Equipment Condition:	No Damage
Purchase Authorization:	Verified

Information Provided by the Party Requesting the Test

Functional Description of the EUT:
The TWIG V UNO radio module is configured to transmit and receive LoRa® chirp-based modulation. The radio module can be configured to transmit on either an internal trace antenna or an external antenna.

Testing Objective:
To obtain 2D antenna pattern measurements of the internal trace antenna and calculated antenna performance values.

CONFIGURATIONS

Configuration NELS0015-3

EUT			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
LoRa Transceiver	Nelson Irrigation Corporation	TWIG V UNO	Sample 3

MODIFICATIONS

Equipment Modifications

Item	Date	Test	Modification	Note	Disposition of EUT
1	2023-07-26	2D Antenna Pattern Measurements	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	Scheduled testing was completed.

2D ANTENNA PATTERN MEASUREMENTS

PSA-ESCI 2023.04.25.0

Testing was performed using the mode(s) of operation and configuration(s) noted within the report. The individuals and/or the organization requesting the test provided the modes, configurations and settings used to complete the evaluation. The actual test parameters are specified in the test data, this includes items such as investigated frequency range (scanned) and test levels. The testing methods and performance specifications, as well as the test site used for the evaluation are indicated in the test data. The test data represents the configuration / operating mode/ model that produced the highest emission levels as compared to the specification limit.

MODES OF OPERATION

CW, 915 MHz

CONFIGURATIONS INVESTIGATED

NELS0015 - 3

FREQUENCY RANGE INVESTIGATED

Start Frequency	915 MHz	Stop Frequency	915 MHz

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Generator - Signal	Keysight	N5182B	TFU	2022-12-02	2024-12-02
Antenna - Dipole	EMCO	3121C-DB4	ADTD	2023-05-31	2026-05-31
Antenna - Biconilog	Teseq	CBL 6141B	AXR	2022-11-01	2024-11-01
Cable	N/A	Bilog Cables	EVA	2022-11-03	2023-11-03
Analyzer - Spectrum Analyzer	Keysight	N9010A	AFO	2022-09-08	2023-09-08

TEST DESCRIPTION

Measurements were performed in a semi-anechoic chamber at a 3 m distance. To simulate free space, the ground plane was covered with RF absorbing cones. The reference antenna was placed on a block of low permittivity foam with a height of 1.8 m.

A signal generator was connected to the reference antenna using a low loss RF cable. To minimize the influence of the RF cable in the radiating pattern, the cable was lined with snap on ferrites at a separating distance of 10 cm.

A CW tone was provided to the calibrated reference antenna and reference scans were collected at the frequencies noted in this test report.

Using the same test setup, the antenna under test (AUT) was placed into the chamber. A polar plot was collected at the antenna height of maximum field strength. This plot was then compared to the reference antenna scan. Using the antenna gain (dBi) of the reference antenna the absolute gain of the AUT was calculated.

SUMMARY OF RESULTS

Antenna Type: Meandering Monopole			
F (MHz)	Pk Gain (dBi)	Avg Gain (dBi)	3 dB BW (deg)
915	-3.4	-9.5	83

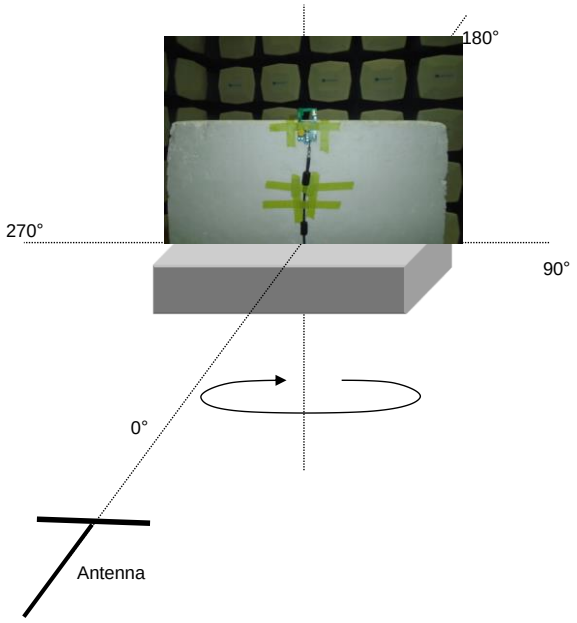
2D ANTENNA PATTERN MEASUREMENTS

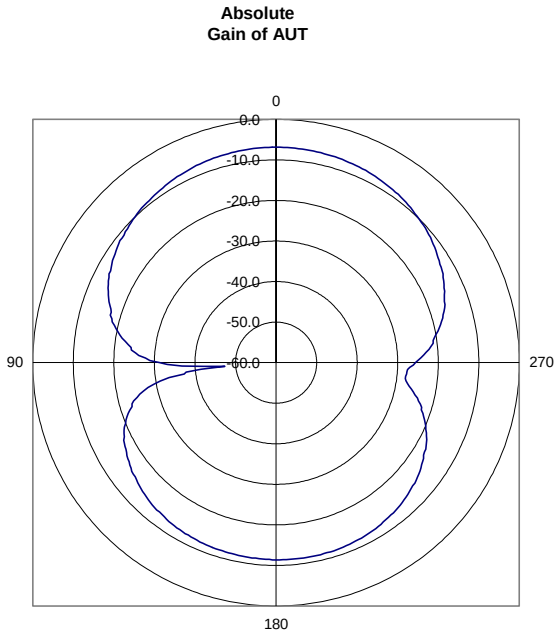
EmiR5 2022.07.06.0 PSA-ESCI 2023.04.25.0

Work Order:	NELS0015	**Date:**	2023-07-26		
Project:	None	**Temperature:**	23°C		
Job Site:	EV01	**Humidity:**	47.80%		
Serial Number:	Sample 3	**Barometric Pres.:**	1018 mbar	**Tested by:**	Jay Whitworth and Cole Ghizzone
EUT:	TWIG V UNO				
Configuration:	NELS0015-3				
Customer:	Nelson Irrigation Corporation				
Attendees:	Mark Bauman				
EUT Power:	None				
Operating Mode:	CW, 915 MHz				
Deviations:	None				
Comments:	None				

Frequency	**915**	Absolute Gain of Reference Antenna (dBi)	0.53
Measurement Antenna Polarity	**Horizontal**	Reference Antenna Relative Gain Max (dBuV/m)	111.82
Antenna Under Test (AUT) Polarity	**Vertical**	AUT Relative Gain Max (dBuV/m)	104.02
Maximum Absolute Gain of AUT (dBi)	**-6.87**	Difference (Reference Antenna - AUT) (dB)	7.80
Average Absolute Gain of AUT (dBi)	**-14.55**	AUT Setup Loss (dB)	**0.4**
		Correction Factor (Convert Relative to Absolute Gain) (dB)	**110.89**
3 dB Beamwidth	**88°**		

Run #		**Test Distance (m)**		**Antenna Height(s)**		**Results**	NA





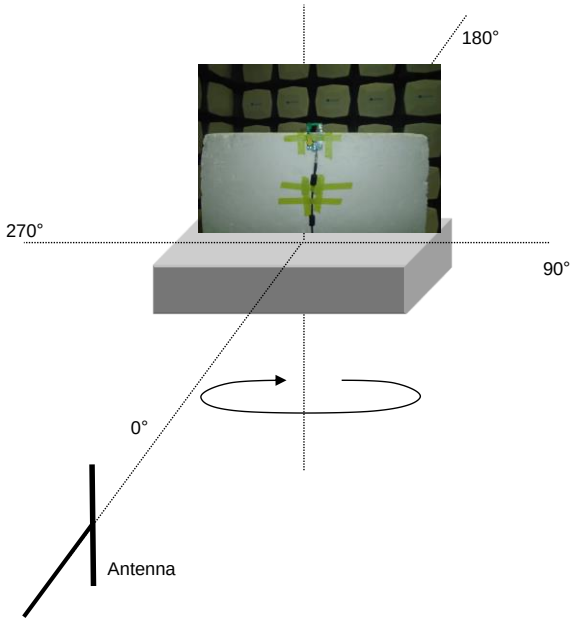
2D ANTENNA PATTERN MEASUREMENTS

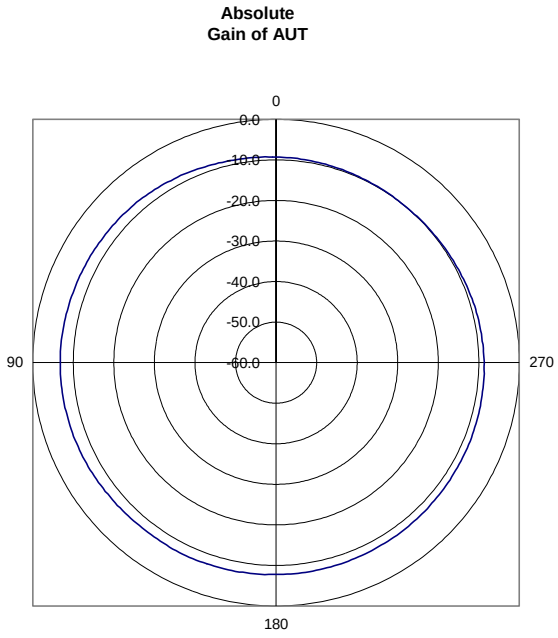
EmiR5 2022.07.06.0 PSA-ESCI 2023.04.25.0

Work Order:	NELS0015	**Date:**	2023-07-26		
Project:	None	**Temperature:**	23°C		
Job Site:	EV01	**Humidity:**	47.80%		
Serial Number:	Sample 3	**Barometric Pres.:**	1018 mbar	**Tested by:**	Jay Whitworth and Cole Ghizzone
EUT:	TWIG V UNO				
Configuration:	NELS0015-3				
Customer:	Nelson Irrigation Corporation				
Attendees:	Mark Bauman				
EUT Power:	None				
Operating Mode:	CW, 915 MHz				
Deviations:	None				
Comments:	None				

Frequency	**915**	Absolute Gain of Reference Antenna (dBi)	0.53
Measurement Antenna Polarity	**Vertical**	Reference Antenna Relative Gain Max (dBuV/m)	111.82
Antenna Under Test (AUT) Polarity	**Vertical**	AUT Relative Gain Max (dBuV/m)	104.12
Maximum Absolute Gain of AUT (dBi)	**-6.77**	Difference (Reference Antenna - AUT) (dB)	7.70
Average Absolute Gain of AUT (dBi)	**-8.19**	AUT Setup Loss (dB)	**0.4**
		Correction Factor (Convert Relative to Absolute Gain) (dB)	**110.89**
3 dB Beamwidth	**325°**		

Run #		**Test Distance (m)**		**Antenna Height(s)**		**Results**	NA





2D ANTENNA PATTERN MEASUREMENTS

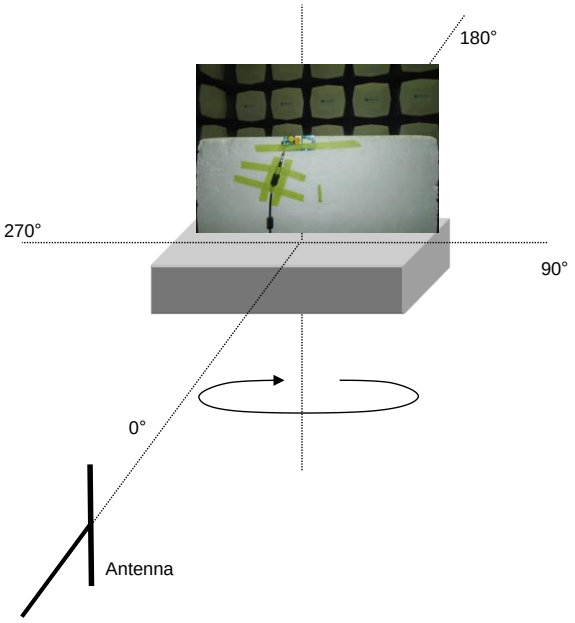
EmiR5 2022.07.06.0 PSA-ESCI 2023.04.25.0

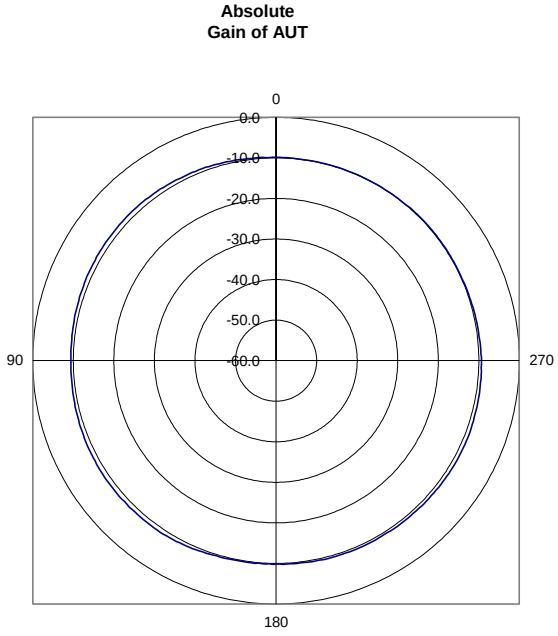
Work Order:	NELS0015	**Date:**	2023-07-26		
Project:	None	**Temperature:**	23°C		
Job Site:	EV01	**Humidity:**	47.80%		
Serial Number:	Sample 3	**Barometric Pres.:**	1018 mbar	**Tested by:**	Jay Whitworth and Cole Ghizzone
EUT:	TWIG V UNO				
Configuration:	NELS0015-3				
Customer:	Nelson Irrigation Corporation				
Attendees:	Mark Bauman				
EUT Power:	None				
Operating Mode:	CW, 915 MHz				
Deviations:	None				
Comments:	None				

Frequency	**915**	Absolute Gain of Reference Antenna (dBi)	0.53
Measurement Antenna Polarity	**Vertical**	Reference Antenna Relative Gain Max (dBuV/m)	111.82
Antenna Under Test (AUT) Polarity	**On Side**	AUT Relative Gain Max (dBuV/m)	102.02
Maximum Absolute Gain of AUT (dBi)	**-8.87**	Difference (Reference Antenna - AUT) (dB)	9.80
Average Absolute Gain of AUT (dBi)	**-9.40**	AUT Setup Loss (dB)	**0.4**
		Correction Factor (Convert Relative to Absolute Gain) (dB)	**110.89**

3 dB Beamwidth

Run #		**Test Distance (m)**		**Antenna Height(s)**		**Results**	NA





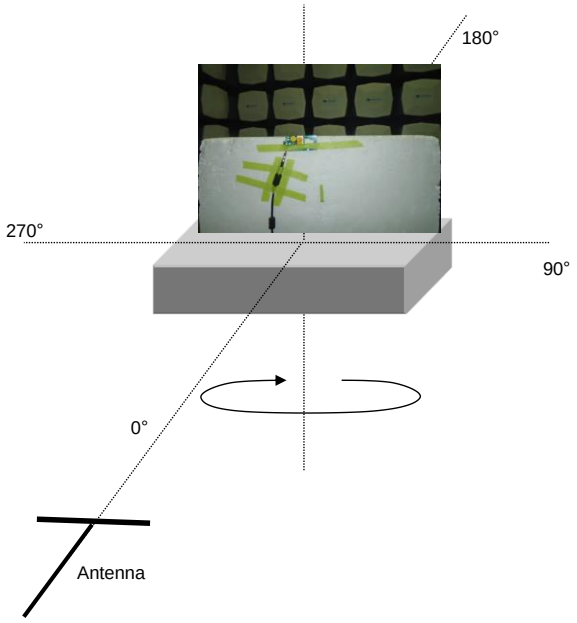
2D ANTENNA PATTERN MEASUREMENTS

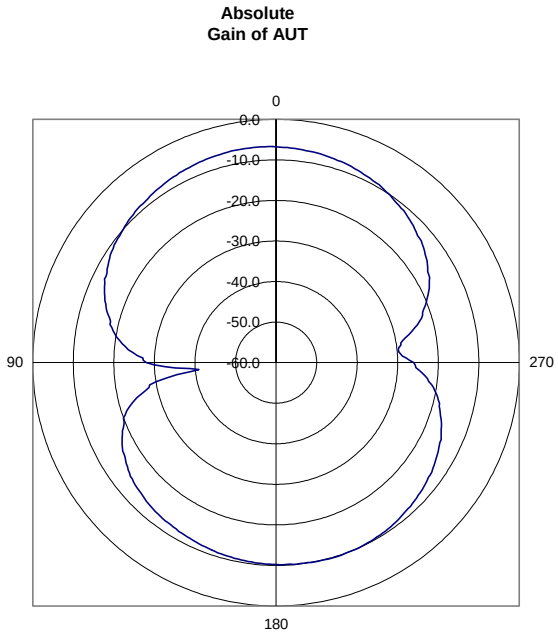
EmiR5 2022.07.06.0 PSA-ESCI 2023.04.25.0

Work Order:	NELS0015	**Date:**	2023-07-26		
Project:	None	**Temperature:**	23°C		
Job Site:	EV01	**Humidity:**	47.80%		
Serial Number:	Sample 3	**Barometric Pres.:**	1018 mbar	**Tested by:**	Jay Whitworth and Cole Ghizzone
EUT:	TWIG V UNO				
Configuration:	NELS0015-3				
Customer:	Nelson Irrigation Corporation				
Attendees:	Mark Bauman				
EUT Power:	None				
Operating Mode:	CW, 915 MHz				
Deviations:	None				
Comments:	None				

Frequency	**915**	Absolute Gain of Reference Antenna (dBi)	0.53
Measurement Antenna Polarity	**Horizontal**	Reference Antenna Relative Gain Max (dBuV/m)	111.82
Antenna Under Test (AUT) Polarity	**On side**	AUT Relative Gain Max (dBuV/m)	104.22
Maximum Absolute Gain of AUT (dBi)	**-6.67**	Difference (Reference Antenna - AUT) (dB)	7.60
Average Absolute Gain of AUT (dBi)	**-14.16**	AUT Setup Loss (dB)	**0.4**
		Correction Factor (Convert Relative to Absolute Gain) (dB)	**110.89**
3 dB Beamwidth	**79°**		

Run #		**Test Distance (m)**		**Antenna Height(s)**		**Results**	NA





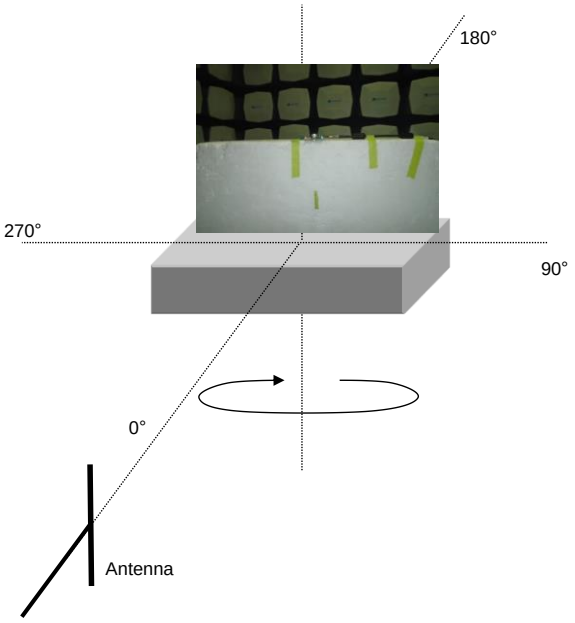
2D ANTENNA PATTERN MEASUREMENTS

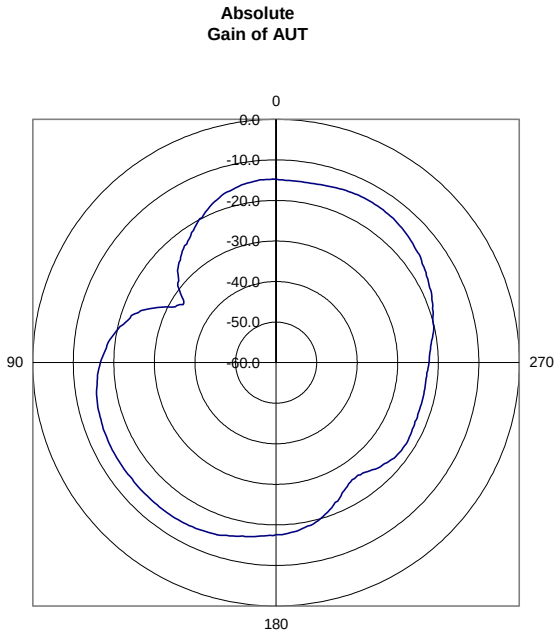
EmiR5 2022.07.06.0 PSA-ESCI 2023.04.25.0

Work Order:	NELS0015	**Date:**	2023-07-26		
Project:	None	**Temperature:**	23°C		
Job Site:	EV01	**Humidity:**	47.80%		
Serial Number:	Sample 3	**Barometric Pres.:**	1018 mbar	**Tested by:**	Jay Whitworth and Cole Ghizzone
EUT:	TWIG V UNO				
Configuration:	NELS0015-3				
Customer:	Nelson Irrigation Corporation				
Attendees:	Mark Bauman				
EUT Power:	None				
Operating Mode:	CW, 915 MHz				
Deviations:	None				
Comments:	None				

Frequency	**915**	Absolute Gain of Reference Antenna (dBi)	0.53
Measurement Antenna Polarity	**Vertical**	Reference Antenna Relative Gain Max (dBuV/m)	111.82
Antenna Under Test (AUT) Polarity	**Horizontal**	AUT Relative Gain Max (dBuV/m)	96.92
Maximum Absolute Gain of AUT (dBi)	**-13.97**	Difference (Reference Antenna - AUT) (dB)	14.90
Average Absolute Gain of AUT (dBi)	**-18.92**	AUT Setup Loss (dB)	**0.4**
		Correction Factor (Convert Relative to Absolute Gain) (dB)	**110.89**
3 dB Beamwidth	**79°**		

Run #		**Test Distance (m)**		**Antenna Height(s)**		**Results**	NA





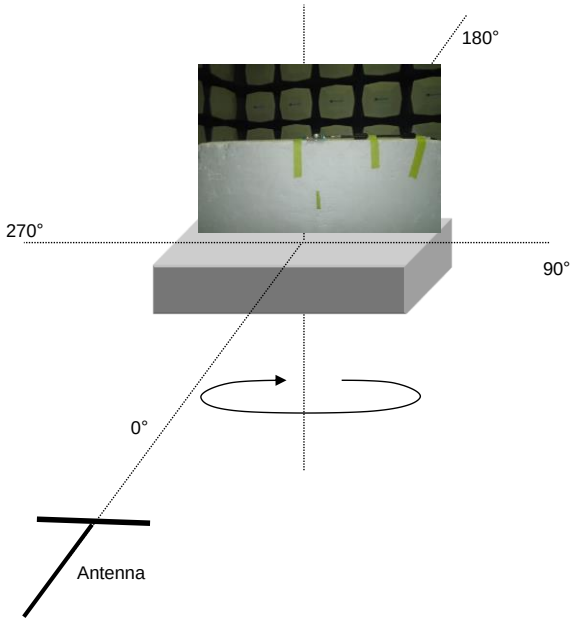
2D ANTENNA PATTERN MEASUREMENTS

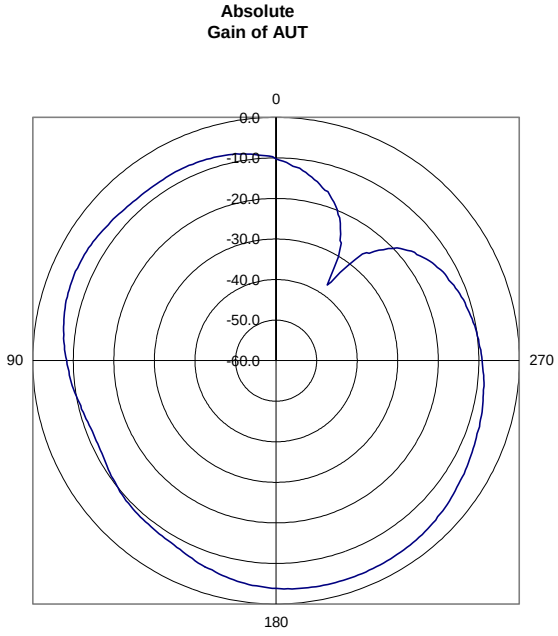
EmiR5 2022.07.06.0 PSA-ESCI 2023.04.25.0

Work Order:	NELS0015	**Date:**	2023-07-26		
Project:	None	**Temperature:**	23°C		
Job Site:	EV01	**Humidity:**	47.80%		
Serial Number:	Sample 3	**Barometric Pres.:**	1018 mbar	**Tested by:**	Jay Whitworth and Cole Ghizzone
EUT:	TWIG V UNO				
Configuration:	NELS0015-3				
Customer:	Nelson Irrigation Corporation				
Attendees:	Mark Bauman				
EUT Power:	None				
Operating Mode:	CW, 915 MHz				
Deviations:	None				
Comments:	None				

Frequency	**915**	Absolute Gain of Reference Antenna (dBi)	0.53
Measurement Antenna Polarity	**Horizontal**	Reference Antenna Relative Gain Max (dBuV/m)	111.82
Antenna Under Test (AUT) Polarity	**Horizontal**	AUT Relative Gain Max (dBuV/m)	107.52
Maximum Absolute Gain of AUT (dBi)	**-3.37**	Difference (Reference Antenna - AUT) (dB)	4.30
Average Absolute Gain of AUT (dBi)	**-9.48**	AUT Setup Loss (dB)	**0.4**
		Correction Factor (Convert Relative to Absolute Gain) (dB)	**110.89**
3 dB Beamwidth	**83°**		

Run #		**Test Distance (m)**		**Antenna Height(s)**		**Results**	NA





2D ANTENNA PATTERN MEASUREMENTS

PSA-ESCI 2023.04.25.0