Nelson Irrigation Corporation

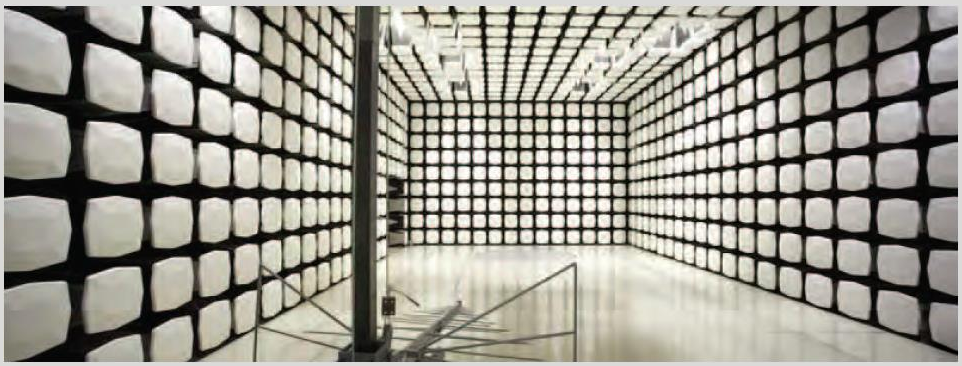
TWIG-V

FCC 2.1091:2019

LoRa Radio

Bluetooth Low Energy (BLE)

Report # NELS0008.4



NVLAP Lab Code: 200630

CERTIFICATE OF EVALUATION

Last Date of Evaluation: Wednesday, September 25, 2019
Nelson Irrigation Corporation
EUT: TWIG-V

RF Exposure Evaluation

Standards

Specification	Method
FCC 2.1091:2019	FCC 447498 D01 General RF Exposure Guidance v06

Results

Method Clause	Description	Applied	Results	Comments
7.2	Maximum Permissible Exposure	Yes	Pass	None

Deviations From Evaluation Standards

None

Approved By:

Donald Facteau, Process Architect

Product compliance is the responsibility of the client; therefore, the tests and equipment modes of operation represented in this report were agreed upon by the client, prior to testing. The results of this test pertain only to the sample(s) tested. The specific description is noted in each of the individual sections of the test report supporting this certificate of test. This report reflects only those tests from the referenced standards shown in the certificate of test. It does not include inspection or verification of labels, identification, marking or user information. As indicated in the Statement of Work sent with the quotation, Element's standard process is to always use the latest published version of the test methods even when earlier versions are cited in the test specification. Issuance of a purchase order was de facto acceptance of this approach. Otherwise, the client would have advised Element in writing of the specific version of the test methods they wanted applied to the subject testing

REVISION HISTORY

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

ACCREDITATIONS AND AUTHORIZATIONS

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 - Accredited by A2LA to ISO / IEC 17065 as a product certifier. This allows Element to certify transmitters to FCC and IC specifications.

NVLAP - Each laboratory is accredited by NVLAP to ISO 17025

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 – Within Element, we have a EU Notified Body validated for the EMCD and RED Directives.

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

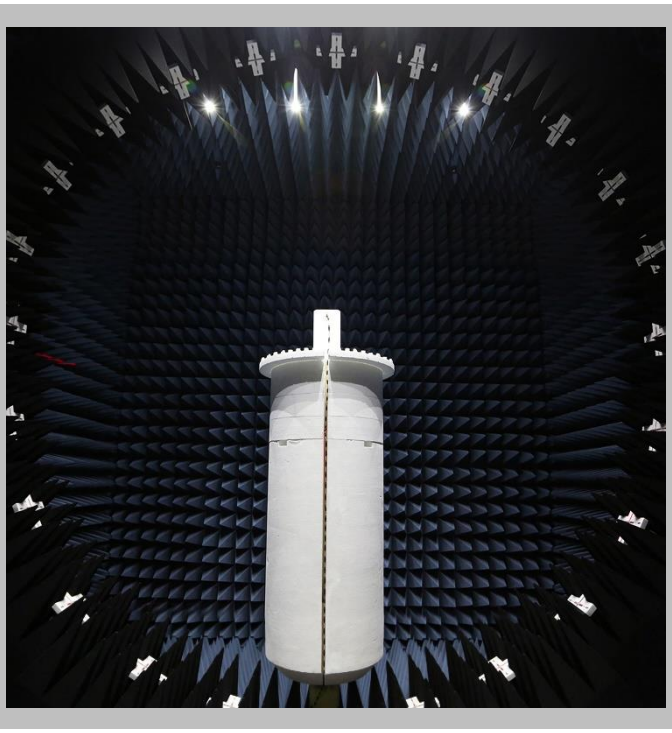
MIC – Recognized by MIC as a CAB for the acceptance of test data.

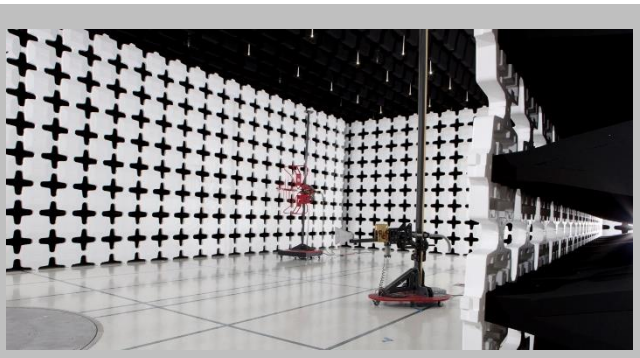
SCOPE

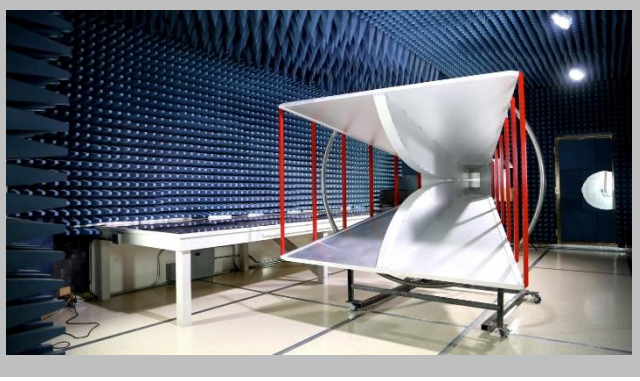
For details on the Scopes of our Accreditations, please visit:
https://www.nwemc.com/emc-testing-accreditations

FACILITIES

California	Minnesota	Oregon	Texas	Washington
Labs OC01-17 41 Tesla Irvine, CA 92618 (949) 861-8918	Labs MN01-10 9349 W Broadway Ave. Brooklyn Park, MN 55445 (612)-638-5136	Labs EV01-12 6775 NE Evergreen Pkwy #400 Hillsboro, OR 97124 (503) 844-4066	Labs TX01-09 3801 E Plano Pkwy Plano, TX 75074 (469) 304-5255	Labs NC01-05 19201 120th Ave NE Bothell, WA 98011 (425)984-6600
NVLAP				
NVLAP Lab Code: 200676-0	NVLAP Lab Code: 200881-0	NVLAP Lab Code: 200630-0	NVLAP Lab Code:201049-0	NVLAP Lab Code: 200629-0
Innovation, Science and Economic Development Canada				
2834B-1, 2834B-3	2834E-1, 2834E-3	2834D-1	2834G-1	2834F-1
BSMI				
SL2-IN-E-1154R	SL2-IN-E-1152R	SL2-IN-E-1017	SL2-IN-E-1158R	SL2-IN-E-1153R
VCCI				
A-0029	A-0109	A-0108	A-0201	A-0110
Recognized Phase I CAB for ISED, ACMA, BSMI, IDA, KCC/RRA, MIC, MOC, NCC, OFCA				
US0158	US0175	US0017	US0191	US0157







RF Exposure Condition

The following RF Exposure conditions were used for the assessment documented in this report:	
Intended Use	Mobile
Location on Body (if applicable)	NA
How is the Device Used	The radio module will be used in hosts manufactured by Nelson irrigation. These hosts will be either fastened to a wall, mounted on a pole, or positioned on a hydraulic valve.
Radios Contained in the Same Host Device	BLE LoRa
Simultaneous Transmitting Radios	BLE, LoRa (when connected to the internal bow-tie antenna)
Body Worn Accessories	None.
Environment	General Population/Uncontrolled Exposure

PRODUCT DESCRIPTION

Client and Equipment Under Evaluation Information

Company Name:	Nelson Irrigation Corporation
Address:	848 Airport Road
City, State, Zip:	Walla Walla, WA 99362-2271
Evaluation Requested By:	Mark Bauman
EUT:	TWIG-V
Date of Evaluation:	Wednesday, September 25, 2019

Information Provided by the Party Requesting the Evaluation

Functional Description of the Equipment:
The TWIG-V module has a LoRa radio and includes a BLE radio module (FCC ID: S9NSPBTLERF). The BLE radio is employed for initial set-up. The LoRa radio communicates with other LoRa radio modules for the application of irrigation controls. The LoRa radio module is certified for use with three different types of antenna. When the on-board bow-tie antenna is used for the LoRa radio, the LoRa radio and the BLE radio can simultaneously transmit. For the other two antenna options, the BLE radio is not co-located with the LoRa radio.

Objective:
To demonstrate compliance with FCC requirements for RF exposure for 2.1091 mobile/fixed devices.

MAXIMUM PERMISSIBLE EXPOSURE (MPE)

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EXRPT.2019.04.10

OVERVIEW

Human exposure to RF emissions from mobile devices (47 CFR §2.1091) may be evaluated based on the MPE limits adopted by the FCC for electric and magnetic field strength and/or power density, as appropriate, since exposures are assumed to occur at distances of 20 cm or more from persons. ANSI C95.1:2005 + Amd 1:2010 specifies a minimum separation distance of 20 cm for performing reliable field measurements to determine adherence to MPE limits. If the minimum separation distance between a transmitter and nearby persons is more than 20 cm under normal operating conditions, compliance with MPE limits may be determined at such distance from the transmitter. When applicable, operation instructions and prominent warning labels may be used to alert the exposed persons to maintain a specified distance from the transmitter or to limit their exposure durations and usage conditions to ensure compliance. If the use of warning labels on a transmitter is not effective or desirable, the alternative of performing SAR evaluation with the device at its closest range to persons under normal operating conditions may be used. The field strength and power density limits adopted by the FCC are based on whole-body averaged exposure and the assumption of RF field levels relate most accurately to estimating whole-body averaged SAR. This means some local values of exposures exceeding the stated field strength and power density limits may not necessarily imply non-compliance if the spatial average of spatially averaged RF fields over the exposed portions of a person's body does not exceed the limits.

COMPLIANCE WITH FCC 2.1091

"Mobile devices that operate in the Cellular Radiotelephone Service, the Personal Communications Services, the Satellite Communications Services, the General Wireless Communications Service, the Wireless Communications Service, the Maritime Services and the Specialized Mobile Radio Service authorized under subpart H of part 22 of this chapter, parts 24, 25, 26 and 27 of this chapter, part 80 of this chapter (ship earth stations devices only) and part 90 of this chapter are subject to routine environmental evaluation for RF exposure prior to equipment authorization or use if they operate at frequencies of 1.5 GHz or below and their effective radiated power (ERP) is 1.5 watts or more, or if they operate at frequencies above 1.5 GHz and their ERP is 3 watts or more. Unlicensed personal communications service devices, unlicensed millimeter wave devices and unlicensed NII devices authorized under §§15.253, 15.255, and 15.257, and subparts D and E of part 15 of this chapter are also subject to routine environmental evaluation for RF exposure prior to equipment authorization or use if their ERP is 3 watts or more or if they meet the definition of a portable device as specified in §2.1093(b) requiring evaluation under the provisions of that section. All other mobile and unlicensed transmitting devices are categorically excluded from routine environmental evaluation for RF exposure prior to equipment authorization or use, except as specified in §§1.1307(c) and 1.1307(d) of this chapter. Applications for equipment authorization of mobile and unlicensed transmitting devices subject to routine environmental evaluation must contain a statement confirming compliance with the limits specified in paragraph (d) of this section as part of their application."

The device will only be used with a separation distance between the antenna and the body of the user or nearby persons as shown in the table below and can therefore be considered a mobile transmitter per 47 CFR 2.1091(b).

COMPLIANCE WITH FCC KDB 447498 D01 General RF Exposure Guidance v06

"KDB 447498 D01 General RF Exposure Guidance v06" provides the procedures, requirements, and authorization policies for mobile and portable devices.

Devices operating in standalone mobile device exposure conditions may contain a single transmitter or multiple transmitters that do not transmit simultaneously are covered in section 7.1.

Devices containing multiple transmitters capable of simultaneous transmissions are covered in section 7.2.

MAXIMUM PERMISSIBLE EXPOSURE (MPE)

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LIMITS

Limits for General Population /Uncontrolled Exposure: 47 CFR 1.1310

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm^2)	Averaging Time (minutes)
0.3 - 1.34	614	1.63	*(100)	30
1.34 - 30	824/f	2.19/f	*($180/f^2$)	30
30 - 300	27.5	0.073	0.2	30
300 - 1500			f/1500	30
1500 - 100000			1	30

f = frequency in MHz
*** = Plane-wave equivalent power density**

ASSESSMENT

The exposure level for the radio is evaluated at a 20 cm distance from the radio's transmitting antenna using the general equation:

$$S = \frac{P * G}{4 * \pi * R^2}$$

Where: S = power density (mW/cm^2)
P = power input to the antenna (mW)
G = numeric power gain relative to an isotropic radiator
R = distance to the center of the radiation of the antenna (20 cm = limit for MPE estimates)
P*G = EIRP

Solving for S, the maximum power density 20 cm from the transmitting antenna is determined. This level is then compared to the applicable limit for the transmit frequency. If limits were not met at the 20 cm boundary the evaluation distance is increased until the limit is met as shown in the table below.

For co-located radios, the ratio of the calculated level to the limit is determined. The ratios for each co-located radio are summed. If the sum is less than or equal to one, then the device is excluded from testing and is deemed compliant.

Two different operational conditions were assessed:

1. The condition under which the LoRa radio, connected to the bow-tie antenna on the module and the BLE radio are able to simultaneously transmit.

2. The condition under which the LoRa radio, connected to the highest gain antenna (12 dBi) and the BLE radio are not able to simultaneously transmit.

In both cases, the source-based duty cycle of the LoRa radio is conservatively defined as 25% in the evaluation. Mark Bauman, Electrical Engineer and Patent Agent at Nelson Irrigation provided the following explanation:

MAXIMUM PERMISSIBLE EXPOSURE (MPE)

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EXRPT.2019.04.10

"In normal operation, our duty cycle is very low (less than 1%) but it is possible to operate the system as high as 25% duty cycle…but not for any length of time, because there wouldn't be enough time to get return packets."

Case 1. LoRa radio, with bow-tie antenna, and BLE radio do simultaneously transmit.

The standalone MPE and summed MPE ratios are summarized in the following table:

Radio	Transmit Frequency (MHz)	Measured Conducted Output Power (dBm)	Duty Cycle	Highest Antenna Gain (dBi)	Minimum Antenna Cable Loss (dB)	Minimum Separation Distance (cm)	Power Density (mW/cm^2)	Limit (mW/cm^2)	Ratio
LoRa	902.5	24.2	0.25	2	0	20	0.021	0.6	0.0345
								Max Ratio	0.0345

The information in the table above was obtained from:
From client supplied information and Element Report# NELS0008.1.

Radio	Transmit Frequency (MHz)	Measured Conducted Output Power (mW)	Duty Cycle	Highest Antenna Gain (dBi)	Minimum Antenna Cable Loss (dB)	Minimum Separation Distance (cm)	Power Density (mW/cm^2)	Limit (mW/cm^2)	Ratio
BLE	2480	2.3	1	0.5	0	20	0.00052	1.0	0.00052
								Max Ratio	0.00052

The information in the table above was obtained from:
From client supplied information and IMQ report# ARSP00054-1 for FCC ID: S9NSPBTLERF.

Sum of Maximum Ratios	Limit	Compliant
0.0350	1	Yes

Case 2. LoRa radio, with 12 dBi antenna, and BLE radio do not simultaneously transmit.

The standalone MPE and summed MPE ratios are summarized in the following table:

Radio	Transmit Frequency (MHz)	Measured Conducted Output Power (dBm)	Duty Cycle	Highest Antenna Gain (dBi)	Minimum Antenna Cable Loss (dB)	Minimum Separation Distance (cm)	Power Density (mW/cm^2)	Limit (mW/cm^2)	Compliant
LoRa	902.5	24.2	0.25	12	0	20	0.2073	0.6	Yes

The information in the table above was obtained from:
From client supplied information and Element Report# NELS0008.1

Radio	Transmit Frequency (MHz)	Measured Conducted Output Power (mW)	Duty Cycle	Highest Antenna Gain (dBi)	Minimum Antenna Cable Loss (dB)	Minimum Separation Distance (cm)	Power Density (mW/cm^2)	Limit (mW/cm^2)	Compliant
BLE	2480	2.3	1	0.5	0	20	0.00052	1.0	Yes

The information in the table above was obtained from:
From client supplied information and IMQ report# ARSP00054-1 for FCC ID: S9NSPBTLERF.