

ENGINEERING TEST REPORT # TR314035 A LSR Job #: C-1898

Compliance Testing of: VRS (TWIG)

<u>Test Date(s)</u>: 10/3/2016 to 10/6/2016

<u>Prepared For:</u> Nelson Irrigation Corp Attn: Mark Bauman, P.E. 848 Airport Road Wala Walla, WA 99362

This Test Report issued: Khairul Aidi Zainal, Engineering Manager – Test Serv	vices
Signature: Hubble Date: 10/7/16	
Quality Assurance by:	Report hv.
Tom Smith, Director of EMC Compliance	Khairul Aidi Zainal, Engineering Manager – Test Services
Signature: Thomas T.Smith Date: 10/7/2016	Signature: Muhid Date: 10/7/16

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Report: TR 314035	Model: NIC-11543-01			
LSR: C-1898	MAC ID: 00:25:CA:08:00:00:05:15			
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LS Research, LLC in Review

As an EMC Testing Laboratory, our Accreditation and Assessments are recognized through the following:



TESTING CERT #1255.01

<u>A2LA – American Association for Laboratory Accreditation</u>

Accreditation based on ISO/IEC 17025: 2005 with Electrical (EMC) Scope of Accreditation A2LA Certificate Number: 1255.01



Federal Communications Commission (FCC) – USA

Listing of 3 Meter Semi-Anechoic Chamber based on Title 47 CFR – Part 2.948 FCC Registration Number: 90756

Industrie Industry Canada Canada

Canada

Industry Canada

On file, 3 Meter Semi-Anechoic Chamber based on RSS-212 – Issue 1 File Number: IC 3088-A On file, 3 and 10 Meter OATS based on RSS-212 – Issue 1 File Number: IC 3088



U. S. Conformity Assessment Body (CAB) Validation

Validated by the European Commission as a U. S. Competent Body operating under the U. S./EU, Mutual Recognition Agreement (MRA) operating under the European Union Electromagnetic Compatibility –Council Directive 2004/108/EC (formerly 89/336/EEC, Article 10.2).

Date of Validation: January 16, 2001

Validated by the European Commission as a U.S. Notified Body operating under the U.S. /EU, Mutual Recognition Agreement (MRA) operating under the European Union Telecommunication Equipment – Council Directive 99/5/EC, Annex V. Date of Validation: November 20, 2002 Notified Body Identification Number: 1243

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1.0 Summary of Test Report

In October 2016 the EUT, VRS(TWIG), as provided by Nelson Corporation was tested and MEETS the following requirements:

FCC Requirement	IC Requirement	Test Requirements Measurement Procedure		Compliance (Yes/No)	
15.247 (a)(2)	RSS-247	6 dB Bandwidth of a Digital	ANSI C63.10-2013	Yes	
13.247(a)(2)	Section 5.2 (1)	Modulation System	Section 11.8		
15.247(b) &	RSS-247	Maximum Output Power	ANSI C63.10-2013	Yes	
1.1310	Section 5.4 (4)	Maximum Output Fower	Section 11.9		
15.247(a)	RSS-247	Power Spectral Density of a	ANSI C63.10-2013	Vac	
13.247 (8)	Section 5.2 (2)	Digital Modulation System	Section 11.10	res	
15.247(d)	RSS-247 Section 5.5	RF Conducted Spurious Emissions at the Transmitter Antenna Terminal	ANSI C63.10-2013 Section 11.11, 11.12.2	Yes	
15.247(c),	RSS-GEN	T	ANSI C63.10-2013		
15.209 &	Section 8.9,	in Destricted Dands	Section 11.12	Yes	
15.205	8.10	In Restricted Bands	(6.3,6.5,6.6)		
21055(4)	RSS-GEN	Enggyon ov Stability	ANSI C63.10-2013		
2.1055 (d)	Section 6.11	Frequency Stability	Section 6.8	res	
15 207	RSS-GEN	Power Line Conducted	Power Line Conducted ANSI C63.10-2013		
13.207	Section 8.8	Emissions Measurements	Section 6.2	res	

2.0 Test Facilities

All testing was performed at:

LS Research, LLC W66 N220 Commerce Court Cedarburg, Wisconsin, 53012 USA

LS Research, LLC is accredited by A2LA (American Association for Laboratory Accreditation) to the requirements of ISO/IEC 17025, 2005 "General Requirements for the Competence of Calibration and Testing Laboratories".

LS Research, LLC's scope of accreditation includes all test methods listed herein, unless otherwise noted.

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3.0 Client Information

Manufacturer Name:	Nelson Irrigation
Address:	848 Airport Road, Wala Walla, WA 99362
Contact Person:	Mark Bauman, P.E.

3.1 Equipment Under Test (EUT) Information

The following information has been supplied by the applicant.

Product Name:	VRS(TWIG)
Model Number:	NIC-11543-01
MAC ID:	00:25:CA:08:00:00:05:15

3.2 Product Information (As provided by customer)

The VRS (TWIG) module is a high performance 900MHz IEEE 802.15.4 radio (AT86RF212 & RF amplifier and low noise amplifier circuit) and microcontroller (ATXMEGA256A3).

Microcontroller

The Atmel XMEGA A3 is a family of low power, high performance and peripheral rich CMOS 8/16-bit microcontrollers based on the AVR® enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the XMEGA A3 achieves throughputs approaching 1 Million Instructions Per Second (MIPS), thus allowing the system designer to optimize power consumption versus processing speed.

Radio

The Atmel AT86RF212 is a low-power, low-voltage 800/900 MHz transceiver specially designed for low-cost IEEE 802.15.4, ZigBeeTM, and high data rate ISM applications. Furthermore hardware accelerators improve overall system power efficiency and timing.

RF Front End Module

The module contains a high performance RF Front End Module for 900MHz wireless applications. It also has a built in low noise amplifier for the receiver to increase sensitivity and all antenna switching.

Associated antennas:

+6 dBi Dipole Antenna

The HyperGain® HGV-906 is a high performance omni-directional antenna designed for the 900 MHz band. It is ideally suited for multipoint, Non Line of Sight (NLOS) and mobile applications where high gain and wide coverage is desired.

Per the manufacturer, the antenna operates in 824-960 MHz range. The maximum gain is +6 dBi.

Articulating Dipole Antenna

A dipole with a gain of +2.0 dBi was connected to both ports of the radio board. The antenna can articulate 90 degrees.

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Bowtie Antenna

A custom bowtie-PCB antenna with a gain of +3.7 dBi.

Custom Antenna

A custom PCB antenna with a gain of -9.9 dBi.

3.3 Modifications Incorporated In the EUT for Compliance Purposes

None noted at time of test

3.4 Deviations & Exclusions from Test Specifications

None noted at time of test

3.5 Additional Information

EUT programmed for necessary test modes via USB cable connected to laptop computer running LSR Modflex Test tool suite version 2.6.2.0. Test channels; Low Channel (906 MHz), Mid Channel (914 MHz), and High Channel (924 MHz). Settings used during testing (Except for Transmit power):

										LQI Las	N Average t Message	-
F.O. #	DE Evol	05.0-1-	0.0	0.6.6	F 1 F	20	THE 0	5	0	Res	et Module	nory
Test Mod Idle Recei Tx Ur Tx Ur Tx Mc	e we modulate modulated eudo Rar	ed 0 ed 1 ndom Bine	ary Sequer	100	RF	Channel 1	Transmit 21 Set RF Moc	Power Test le	Match	ing Control 0	11001	
RF Physi BPSK OQPS OQPS OQPS OQPS	cal Layer -40kbps 5K-SIN-2 5K-SIN-5(5K-SIN-1) 5K-SIN-1)	Mode 50kbps 00kbps Mbps-SCF Mbps-SCF	R-ON R-OFF		2PSI 2PSI 2PSI 2PSI	K-RC-2500 K-RC-5000 K-RC-1Mb K-RC-1Mb	kbps kbps ps-SCR-ON ps-SCR-OF	I F				
RF Front E	ind Contro tenna 1 tenna 2	1		in the second se	A Lov A Hig	w Gain gh Gain						

Transmit power setting in the LSR Modflex test tool was <u>'8'</u>.

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3.6 EUT Technical Specifications

EUT Frequency Range (in MHz)	906-924 MHz
Minimum Conducted Output power in Watts	0.091
Maximum Conducted Output power in Watts	0.102
Minimum Conducted Output Power (in dBm)	19.6
Maximum Conducted Output Power (in dBm)	20.1
Occupied Bandwidth (99% BW) (MHz)	1.196
DTS Bandwidth (MHz)	0.789
Type of Modulation	O-QPSK
Emission Designator	1M20D1X
Transmitter Spurious (worst case) at 3 meters	26.3dBuV/m @ 3m (320MHz)
Frequency Tolerance %, Hz, ppm	Better than 100 ppm
Antenna Information	
Detachable/non-detachable	Detachable
Туре	Dipole, Bowtie, Articulating Dipole, Custom
Gain (in dBi)	6.0 dBi, 3.7 dBi, 2.0 dBi, -9.9 dBi
EUT will be operated under FCC Rule Part(s)	15.247
EUT will be operated under RSS Rule Part(s)	RSS 247
Modular Filing	🛛 Yes 🗌 No
Portable or Mobile?	Mobile

4.0 Conditions of Test

Environmental:

Temperature:20-25° CRelative Humidity:30-60%Atmospheric Pressure:86-106 kPa

Mains Voltage: 120VAC 60Hz

5.0 Test Equipment

All test equipment is calibrated by a calibration laboratory accredited by A2LA to the requirements of ISO 17025. For a complete list of test equipment and calibration dates, see Appendix A. Unless otherwise noted, resolution bandwidth of measuring instrument used during testing for given frequency range, see below.

Frequency Range	Resolution Bandwidth
9 kHz – 150 kHz	200 Hz
150 kHz – 30 MHz	9 kHz
30 MHz – 1000 MHz	120 kHz
Above 1000 MHz	1 MHz

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6.0 Conformance Summary

The EUT was found to MEET the requirements as described within the specification of FCC Title 47, CFR Part 15.247, 15.207, Industry Canada RSS-247, Issue 1 (2015), Annex 8, RSS-GEN Issue 4 (2014).

If some emissions are seen to be within 3 dB of their respective limits:

As these levels are within the tolerances of the test equipment and site employed, there is a possibility that this unit, or a similar unit selected out of production may not meet the required limit specification if tested by another agency.

LS Research, LLC certifies that the data contained herein was taken under conditions that meet or exceed the requirements of the test specifications. The results in this Test Report apply only to the item(s) tested on the above-specified dates. Any modifications made to the EUT subsequent to the indicated test date(s) will invalidate the data herein, and void this certification.

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Appendix A – Test Equipment

4	LSR a Laird Business							
	Date	4-Oct-2016	Type Test :	Radiated Emis	ssions		# dol.	C-1898
	Prepared By:	John Johnston	Customer :	Nelson Irrigati	on Corporation		Quote #	314035
No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960085	N9038A MXE 26.5GHz Receiver	Agilent	N9038A	MY51210148	5/12/2016	5/12/2017	Active Calibration
2	AA 960158	Double Ridge Hom Antenna	ETS Lindgren	3117	109300	2/4/2016	2/4/2017	Active Calibration
3	AA 960156	900MHz High Pass Filter	KWM	HPF-L-14185	unknown	7/25/2016	7/25/2017	Active Calibration
4	EE 960159	0.8 - 21GHz LNA	Mini-Circuits	ZVA-213X-S+	40201429	2/4/2016	2/4/2017	Active Calibration
5	AA 960171	Cable - low loss 6m	A.H. Systems, Inc	SAC-26G-6	386	3/31/2016	3/31/2017	Active Calibration
6	AA 960150	Biconical Antenna	ETS	3110B	0003-3346	2/1/2016	2/1/2017	Active Calibration
7	AA 960163	Log Periodic Antenna	A H. Systems, Inc.	SAS-512-2	500	3/18/2016	3/18/2017	Active Calibration



	Date	: 26-Aug-2014	Type Test :	Conducted mea	surement		Jab #	C-1898
	Prepared By	: <u>Mike</u>	Customer :	Nelson Irrigation	Corporation		Quote #	: 314035
No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
	EE 960087	44GHz EXA Spectrum Analyzer	Agilant	N9010A	MY53400296	12/18/2015	12/18/2016	Active Calibration
	AA 960156	900MHz High Pass Filter	KWM	HPF-L-14185	unknown	7/25/2016	7/25/2017	Active Calibration
	AA 960143	Phasellex	Gore	EKD01D01048.0	5546519	6/26/2015	6/26/2017	Active Calibration

2		2							
	Date	: 26-Aug-2014	Type Test :	AC Mains C	onducted emissions		Job#	: <u>C-1898</u>	
	Prepared By	: John Johnston	Customer :	Netson Irrig	ation Corporation		Quote #	314035	
No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status	
1	EE 960085	N9038A MXE 26.5GHz Receiver	Agilent	N9038A	MY51210148	5/12/2016	5/12/2017	Active Calibration	
2	EE 960089	LISN - 15A	COM-POWER	LI-215A	191943	3/8/2016	3/8/2017	Active Calibration	
3	EE 960162	LISN - 15A	COM-POWER	LI-215A	191969	8/15/2016	8/15/2017	Active Calibration	

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Appendix B – Test Data B.1 – RF Conducted Emissions

Manufacturer	Nelson Corp.
Test Location	LS Research, LLC
Rule Part	FCC 15.247 IC RSS-247
General Measurement Procedure	ANSI C63.10 Section 6.7 and 11
General Description of Measurement	A direct measurement of the transmitted signal was performed at the antenna port of the EUT via a cable connection to a spectrum analyzer. An attenuator was placed in series with the cable to protect the spectrum analyzer. The loss from the cable and the attenuator were added on the analyzer as gain offset settings there by allowing direct measurements, without the need for any further corrections. The EUT was configured to run in a continuous transmit mode, while being supplied with typical data as a modulation source.

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Manufacturer	Nelson Corp
Date	10-3-2016
Operator	Mike Hintzke
Temp. / R.H.	20 - 25° C / 30-60% R.H.
Rule Part	FCC 15.247 (a)(2) IC RSS-247 Section 5.2(1)
Specific Measurement Procedure	ANSI C63.10-2013 Section 11.8
Additional Description of Measurement	Peak detector used
Additional Notes	1. Continuous transmit modulated used for this test.

B.1.1 – RF Conducted – Fundamental Bandwidth

Table

Channel Frequency (MHz)	6dB Bandwidth (MHz)	6dB Bandwidth minimum limit (MHz)	99% OBW (MHz)
906	0.804	0.500	1.193
914	0.803	0.500	1.189
924	0.789	0.500	1.196

	-	
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Manufacturer	Nelson Corp.
Date	10/3/16
Operator	Mike Hinztke
Temp. / R.H.	20 - 25° C / 30-60% R.H.
Rule Part	FCC 15.247 (b) & (e) IC RSS-247 Section 5.4 (4) & 5.2 (2)
Specific Measurement Procedure	ANSI C63.10-2013 Section 11.9 and 11.10
Additional Description of Measurement	Peak Output Power and Peak PSD methods utilized for measurement 3 kHz resolution bandwidth used for Peak Power Spectral Density measurement
Additional Notes	 Continuous transmit modulated used for this test. Sample Calculation: Margin (dB) = Limit – Measured Level

B.1.2 - RF Conducted - Fundamental Power and Spectral Density

Table

Channel Frequency (MHz)	Max Peak Conducted Power (dBm)	Power Limit (dBm)	Power margin (dB)	Peak PSD in 3kHz Minimum BW (dBm)	PSD in 3kHz limit(dBm)	PSD margin (dBm)
906	20.1	30.0	9.9	7.7	8.0	0.3
914	19.9	30.0	10.1	7.6	8.0	0.4
924	19.6	30.0	10.4	7.2	8.0	0.8

Duty Cycle = 100%



Middle channel Note: Low and high channel was checked and duty cycle measured to be 100%

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Plots - Max Power

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	aucteu Spurious Linissions
Manufacturer	Nelson Corp
Date	10/3/16,10/4/16
Operator	Mike Hintzke
Temp. / R.H.	20 - 25° C / 30-60% R.H.
Rule Part	FCC 15.247 (d) IC RSS-247 Section 5.5
Specific Measurement Procedure	ANSI C63.10-2013 Section 11.11 and 11.12
Additional Description of Measurement	Peak output power measurements therefore spurious emissions attenuated 20 dBc. Includes antenna port measurement for restricted band emissions
Additional Notes	 Continuous transmit modulated used for this test. Peak emissions compared to non-peak limits for measurements per section 11.12 of C63.10 (Restricted band emissions) In Restricted band emissions measurement, antenna gain value of 6dBi was included as an external gain on the spectrum analyzer. In Restricted band emissions measurements below 1 GHz, ground reflection factor of 4.7dB and antenna gain of 6dBi was included as an external gain on the spectrum analyzer.

B.1.3 – RF Conducted – Spurious Emissions

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Emissions in non-restricted frequency bands: Low Channel:

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Frequency (MHz)	EIRP (dBm) Peak detector	Limit (dBm)	Margin (dB)
258.4	-60.1	-49.2	10.9
268.7	-59.6	-49.2	10.4
614.0	-64.2	-49.2	15.0
969.9	-42.5	-41.2	1.3
987.8	-43.4	-41.2	2.2
978.0	-42.9	-41.2	1.7
1002.0	-44.7	-41.2	3.5
1010.3	-44.9	-41.2	3.6
1003.8	-44.5	-41.2	3.3

Emissions in Restricted Frequency bands:

Note:

1. Measurements are Peak and compared to quasi peak limit for below 1GHz and Average for above 1 GHz.

Calculation of restricted band limits: From ANSI C63.10 section 11.12.2.2;

 $E = \text{EIRP} - 20 \log d + 104.8$

where

E is the electric field strength in dBµV/m

EIRP is the equivalent isotropically radiated power in dBm

d is the specified measurement distance in m

Restricted band Limit in dBm (EIRP) = Restricted band Limit in dB μ V/m (E) + 20logd - 104.8

Example:

Restricted band limit (*E*) = $46 dB\mu V/m$ at d = 3m

Limit (dBm) = 54 dB μ V/m + 20log (3m) -104.8 = <u>-41.2 dBm</u>

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Low channel emissions



1100 to 10000 MHz

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Image: Second	1 0 0 0 0 Peak Search 0 0 0 Peak Search Peak Search Mkr1 268, 68 MHz Next Peak Next Peak -59,644 dBm Next Pk Right Next Pk Right Next Pk Right Next Pk Right Next Pk Right -1 0 0 0 -1 0 0 0 -1 0 0 0 -1 0 0 0 -1 0 0 0 -1 0 0 0 -1 0 0 0 -1 0 0 0 -1 0 0 0 -1 0 0 0 -1 0 0 0 -1 0 0 0 -1 0 0 0 -1 0 0 0 -1 0 0 <t< th=""><th>Image: Second Second</th><th>EVEN 300 KH2</th><th>Constrainty Constrainty Constrain</th><th>Vertex Control Control</th></t<>	Image: Second	EVEN 300 KH2	Constrainty Constrain	Vertex Control
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Sector Net Flacks Guld Sector Sector Sect	A Story 300.0 MHz	Cogleters Ref 4.00 dBm 100 Image: Second and the	#VBW 300 kHz BVBW 300 kHz 3000 to 90 HZ MOLTARE OF TALE FOR Run FATENCIAL TALE FOR RUN FATENCIAL TALE FOR RUN FATENCIAL TALE FOR RUN FATENCIAL TALE FOR RUN FATENCIAL FATENC	Stop 900.0 MHz Sweep 40.47 ms (1001 pts) IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII	Propertie M 1
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art 30.0 MHz BW 120 kHz BW 1	Marker Delta Marker Delta MkrCF Stop 300.0 MHz 1 st22 ms (1001 pts) 1	00 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 0000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000	RVEW 300 kHz 300 to 90 HZ State C dB FATER C dB	Stop 900.0 MHz Sweep 40.47 ms (1001 pts) (STATUS) OMHz	Propertie
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30 to 300 MHz	C Set dd PM Oct 04, 2013 Trace D 2 B 4 4 Marker O Tree L 2 B 4 4 Marker Marker Mkr CF Step	If Aglest Spectrum Analyse - Seept 3A See 1 to Go Go Go Go Marker 1 1.010300000000 G III 10 dBddlv Ref 4.00 dBm	300 to 90	Avg Type: Log-Pwr Avg Type: Log-Pwr Avg Type: Log-Pwr	00
arker 1978.04000000000H Allos A PRO: Fast Frig: Free Run Arg Type: Log Arg/Hold:>1001 Briddly Ref -4.00 dBm Ref -4.00 dBm	ID Bit Set 68 Model, 2015 Marker wr Trice [J] 2 8 8 8 Marker b or Trice [J] 2 8 8 Marker Alkr1 978.040 MHz MkrCF MkrCF -42.926 dBm MkrCF Step MkrCF	Marker 1 1.01030000000 G	PNO: Fast Fight Atten: 0 dB	Avg Type: Log-Pwr Avg Hold:>100/100	The second se
atBidiy Ref -4.00 dBm	1kr1 978.040 MHz Mkr→CF -42.926 dBm	10 dB/div Ref -4.00 dBm		Ext Gain: -16.00 dB DET	Peak Search
	Mkr→CF Step	1.09		Mkr1 1.010 3 GHz -44.845 dBm	NextP
		-14.0			Next Pk Ri
		-24.0			
	MKr-Start	31.0		-4123 mbr	Next PK L
a the second second and the second second and the second second second second second second second second second	Mkr-Stop	-223 company departmention	an and the second and the second of the second seco	وسوال والدين ووجعا وعلوه والدوار والمار والمار والمعار والمحاجلة	Marker D
a	MkrRefl vi	64 Ú			Mkr
10		340			
4.0		-64.0			Mkr→Ref
	More	-94.0			м
tart 928.00 MHz Res BW 120 kHz #VBW 300 kHz Swee	Stop 1.00000 GHz 4.867 ms (1001 pts)	Start 1.00000 GHz #Res BW 1.0 MHz	#VBW 3.0 MHz	Stop 1.10000 GHz Sweep 1.000 ms (1001 pts)	,
928 to 1000 MHz	RIUS		1000 to 11	00 MHz	
928.00 MHz BW 120 kHz #VBW 300 kHz Sweet 928 to 1000 MHz	More 1 of 2 4.867 ms (1001 pts) Anapar: Sampt Sk me 1889, pc compet	Start 1.00000 GHz Res BW 1.0 MHz	#VBW 3.0 MHz 1000 to 110	Stop 1.10000 GHz Sweep 1.000 ms (1001 pts) (status) 00 MHz	Mk

Middle channel emissions

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1100 to 10000 MHz

	PN0: Fast IFGain:Low	#Atten: 10 dB	Ext Gain: -16.00 dB	DET PERMINAN	1000
	10 dB/div Ref -4.00 dBm		Mkr	3.850 1 GHz -47.559 dBm	NextPeak
	-14.0				Next Pk Right
	34.0				Next Pk Left
	44 0	-	معساسعه	und states beaustices	Marker Delta
	64.0				Mkr→CF
	-64.0				Mkr→RefLvi
	Start 1.100 GHz #Res BW 1.0 MHz #V	BW 3.0 MHz	Sweep 14	Stop 10.000 GHz 87 ms (1001 pts)	More 1 of 2
	uso.		STATUS		
	1	100 to 10	000 MHz		
Prepared For: Nelson Irrigation Corp]	Name: VRS	G(TWIG)	
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High channel emissions

Manufacturer	Nelson Corp
Date	10/4/16
Operator	Mike Hintzke
Temp. / R.H.	20 - 25° C / 30-60% R.H.
Rule Part	FCC 2.1055 RSS-GEN Section 6.11
Specific Measurement Procedure	ANSI C63.10-2013 Section 6.8
Additional Description of Measurement	RF Conducted Measurement
Additional Notes	The power and frequency stability of the device was examined as a function of the input voltage available to the EUT. A Spectrum Analyzer was used to measure the RF output power and frequency at the appropriate frequency markers. Power was supplied by an external bench-type DC power supply and was varied from the nominal. The power was then cycled On/Off to observe system response. No unusual response was observed, the emission characteristics were well behaved, and the system returned to the same state of operation as before the power cycle. Below is data showing stability of the fundamental frequency. Continuous transmit un-modulated used for this test. EUT operates at 3.3 VDC (transceiver) and 4.0VDC (amplifier) nominal

B.1.4 – RF Conducted – Frequency Stability

Table

Frequency Stability f = 906 MHz						
Supply Voltage (VDC)		Frequency	Deviation			
V _{CC}	\mathbf{V}_{PA}	(112)	Hz	Limit (Hz)	Margin (Hz)	
2.8	3.4	90600000	906091448	90600	182048	
3.3	4.0	90600000	906091093	90600	181693	
3.8	4.6	90600000	906090733	90600	181333	

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Frequency Stability f = 914 MHz							
Sup	ply	Froguenov	Deviation				
V _{cc}	\mathbf{V}_{PA}	(Hz)	Hz	Limit (Hz)	Margin (Hz)		
2.8	3.4	914000000	914091477	91400	182877		
3.3	4.0	914000000	914090904	91400	182304		
3.8	4.6	914000000	914091304	91400	182704		

Frequency Stability f = 924 MHz							
Sup	ply	Frequency	Deviation				
V _{cc}	\mathbf{V}_{PA}	(Hz)	Hz	Limit (Hz)	Margin (Hz)		
2.8	3.4	924000000	924091474	92400	183874		
3.3	4.0	924000000	924090308	92400	182708		
3.8	4.6	924000000	924091758	92400	184158		

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Rule Part(s)	FCC: 15.247 / 15.205 / 15.209 IC: RSS-GEN Section 8.9,8.10				
Measurement Procedure	ANSI C63.10 – 2013	ANSI C63.10 – 2013 Section 11.12 (6.3,6.5,6.6)			
Test Location	LS Research, LLC - F	LS Research, LLC - FCC Listed 3 meter Semi-Anechoic Chamber			
Test Distance	See data section	See data section			
EUT Placement	Above 1 GHz: 150 cm height non-conductive table above reference ground plane covered with absorbers Below 1 GHz: 80 cm height non-conductive table above reference ground plane				
Frequency Range of Measurement	Biconical: 30-300 MHzLog Periodic Dipole Array:Double-Ridged Waveguide Horn:Standard Gain 18-26GHz300-1000 MHz1-18 GHz				
Measurement Detectors	30-1000MHz1 - 40 GHz:RBW: 120 kHzRBW : 1MHzVBW: At least 300 kHzVBW: At least 3 (MHz) Peak10 Hz Average			Hz) Peak	
Description of Measurement	 The antenna, cable, pre-amp, and other necessary measurement system correction factors are loaded onto the EMI receiver / spectrum analyzer when the measurements are preformed. The data is gathered and reported as the corrected values. The EUT is placed on a non-conductive pedestal <u>made of expanded polyethylene foam</u> centered on a turn-table in the test location with the antenna at the test distance from the EUT 				
	3) Maximum radiated RF emissions are determined by rotation of azimuth and scanning the sense antenna between 1 and 4 meters in height using both horizontal and vertical antenna polarities. Maximized levels are manually noted at degree values of azimuth and at sense antenna height.				
Example Calculations	Reported Measuremen Cable factor (dB) - applicable)	nt data = Raw receiver amplification factor (v	measurement + Antenr vhen applicable) + Ad	ha Correction Factor + Iditional factor (when	

B.2 – Transmitter Radiated Emissions in Restricted Bands

Limits:

uasi-Peak		
uasi-Peak		
uasi-Peak		
age (>1 GHz)		
Model: NIC-11543-01		
uas uas age		

Manufacturer	Nelson Corp
Date	10/4/16 to 10/5/16
Operator	John Johnston
Temp. / R.H.	20 - 25° C / 30-60% R.H.
Rule Part	FCC 15.247/ 15.205 / 15.209 IC RSS-247 / RSS-GEN
Measurement Procedure	ANSI C63.10-2013 Section 11.12
Test Distance	3 meter
EUT Placement	Above 1 GHz: 150 cm height non-conductive table centered on turn-table with absorbers covering ground plane Below 1 GHz: 80 cm height non-conductive table centered on turn-table
Detectors	Final Measurements: Peak / Max Hold, RBW 1 MHz, Average VBW 30Hz, Peak VBW 3 MHz
Additional Notes	 EUT maximized in orientation, azimuth, and antenna height with maximum results reported. Antenna port terminated with 50 ohms. Screen captures presented are representative of all channels investigated.

B.2.1 – Transmitter Radiated Spurious Emissions in Restricted Bands

Example Calculation: Limit (dBµV/m) – Reading (dBµV/m) = Margin (dB)

Table **30-1000 MHz**

Frequency (MHz)	Channel	Height (m)	Azimuth (degree)	Orientation	Quasi-Peak Reading (dBuV/m)	Quasi-Peak Limit (dBuV/m)	Margin (dB)
37.5	Low	1.00	235	F	20.5	40.0	19.5
256.0	Low	1.00	179	V	22.1	46.0	23.9
256.1	Low	1.00	162	Н	24.2	46.0	21.8
256.0	Mid	1.00	189	н	24.3	46.0	21.7
256.0	High	1.00	172	Н	24.3	46.0	21.7
320.0	High	1.00	276	Н	26.3	46.0	19.7

1-10 GHz

Frequency (MHz)	Height (m)	Azimuth (degree)	Orientation	Peak Reading (dBuV/m)	Average Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Antenna Polarity	Notes
9987.0	1.00	0	V	33.7	21.2	54.0	32.8	Н	Noise Floor
9937.0	1.00	0	v	34.3	21.1	54.0	32.9	v	Noise Floor

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port: TR 314035	Model: NIC-11543-01	
pared For. Nerson integation corp		

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B.3 – AC Mains Conducted Emissions

Rule Part(s)	FCC: 15.207 IC: RSS-247 / RSS-GEN
Measurement Procedure	ANSI C63.4 - 2014 ANSI C63.10 – 2013
Test Location	LS Research, LLC – Conducted Emissions Area
Test Voltage	120 VAC 60 Hz
EUT Placement	80 cm height non-conductive table above reference ground plane
Frequency Range of Measurement	150 kHz – 30 MHz
Measurement Detectors	Peak, Quasi-Peak, Average RBW: 9 kHz VBW: At least 27 kHz
Description of Measurement	 The LISN, cable, limiter, and other necessary measurement system correction factors are loaded onto the EMI receiver / spectrum analyzer when the measurements are preformed. The data is gathered and reported as the corrected values. The EUT is placed on a non-conductive pedestal at appropriate distance from ground planes and plugged into LISN. The LISN used has the ability to terminate the unused port with a 50Ω (ohm) load when switched to either L1 (line) or L2 (neutral). Maximum emissions are determined with peak detector and measurements at select points are made with quasi-peak and average detectors. Results are recorded and compared to limit.
Example Calculations	Reported Measurement data = Raw receiver measurement + LISN Factor + Cable factor (dB) + Additional factor (when applicable)

Limits of Conducted Emissions at the AC Mains Ports:

Frequency Range	Class B Limits (dBµV)		
(MHz)	Quasi-Peak	Average	
0.150 -0.50 *	66-56	56-46	
0.5 - 5.0	56	46	
5.0-30 60 50			
* The limit decreases linearly with the logarithm of the frequency in this range.			

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B.4.1 – AC Mains Conducted Emissions

Manufacturer	Nelson Corp	
Date	10/6/16	
Operator	John Johnston	
Temp. / R.H.	20 - 25° C / 30-60% R.H.	
Rule Part	15.207 / RSS-GEN	
Measurement Procedure	ANSI C63.4 - 2014 ANSI C63.10 - 2013 Section 6.2	
Test Voltage	120 VAC 60 Hz	
EUT Placement	80 cm height non-conductive table, 40 cm from vertical ground plane	
Detectors	Peak; RBW 9 kHz Quasi-Peak and Average	
Additional Notes	 Tested in continuous transmit with no significant difference between operating channels. DC voltage supplied using generic AC/DC wall adapter. 	

Example Calculation: Margin (dB) = Limit (dB μ V) – Reading (dB μ V)

Table – Max Power

		Quasi-Peak	Quasi-Peak		Average	Average	
	Frequency	Measurement	Limit	Margin	Measurement	Limit	Margin
Line	(MHz)	(dBuV)	(dBuV)	(dB)	(dBuV)	(dBuV)	(dB)
1	0.150	42.5	66.0	23.5	33.6	56.0	22.4
1	0.185	41.3	64.3	23.0	32.0	54.3	22.3
1	0.617	34.5	56.0	21.5	26.7	46.0	19.3
2	0.150	37.5	66.0	28.5	27.3	56.0	28.7
2	0.167	37.8	65.1	27.3	28.1	55.1	27.0
2	0.622	34.8	56.0	21.2	28.0	46.0	18.0

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Appendix C - Uncertainty Summary

This uncertainty represents an expanded uncertainty expressed at approximately the 95 % confidence level, using a coverage factor of k=2.

Table of Expanded Uncertainty Values, (K=2) for Specified Measurements

Measurement Type	Particular Configuration	Uncertainty Values
Radiated Emissions	3 – Meter chamber, Biconical Antenna	4.82 dB
	3-Meter Chamber, Log Periodic	
Radiated Emissions	Antenna	4.88 dB
Radiated Emissions	3-Meter Chamber, Horn Antenna	4.85 dB
Absolute Conducted Emissions	Agilent PSA/ESA Series	1.38 dB
AC Line Conducted Emissions	Shielded Room/EMCO LISN	3.20 dB
Radiated Immunity	3 Volts/Meter in 3-Meter Chamber	2.05 Volts/Meter
Conducted Immunity	3 Volts level	2.33 V
EFT Burst, Surge, VDI	230 VAC	54.4 V
ESD Immunity	Discharge at 15kV	3200 V
Temperature/Humidity	Thermo-hygrometer	0.64° / 2.88 %RH

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Appendix D - References

Publication	Year	Title
FCC CFR Parts 0-15	2016	Code of Federal Regulations – Telecommunications
RSS-247 Issue 1	2015	Digital Transmissions Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices
RSS-GEN Issue 4	2014	General Requirements and Information for the Certification of Radio Apparatus
ANSI C63.10	2013	American National Standard of Procedures for Compliance Testing Unlicensed Wireless Devices

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END OF REPORT

Date	Version	Comments	Person
	V0	Initial Draft Release	Aidi Zainal
		Final Version	

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