

BEC INCORPORATED

CERTIFICATION APPLICATION TEST REPORT

TEST STANDARDS:
FCC Part 15 Subpart C, IC RSS-Gen, IC RSS-247
DSS Intentional Radiator

**Woodstream Corporation Model V400M LoRa Radio Control Unit
With Models V450 and V460 Connected Control Rodent Traps**

FCC ID: SNA-V400M
ISED ID: 9458A-V400M

REPORT BEC-1908-03

TEST DATES: 10/24/2018 – 11/02/2018

CUSTOMER:
Woodstream Corporation
69 North Locust Street
Lititz, PA 17543

PREPARED BY: 
Paul Banker, Test Engineer

REVIEWED and APPROVED BY: 
Steve Fanella, Quality Manager

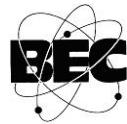
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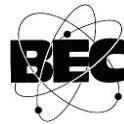
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Revision History

Revision #	Description of Changes	Date of Changes	Date Released
0	Test Report Initial Release	N/A	11/26/2018



1.0 Administrative Information

1.1 Project Details

Project Number	BEC-1908	
Manufacturer	Woodstream Corporation	
Chassis Model Numbers	Connected Control Rodent Traps V450 (Small) and V460 (Large)	
Chassis Model Serial Numbers	None	
LoRa Radio Control Unit Model Number	V400M	
LoRa Radio Control Unit Type	Unmodified Sample	Modified with SMA connector on transmitter output port
LoRa Radio Control Unit Serial #s	None	
LoRa Radio Control Unit Sample Numbers	1908-05	1908-06
FCC ID	SNA-V400M	
ISED ID	9458A-V400M	
Radio Chip Manufacturer	Semtech Corporation	
Radio Chip Model Number	SX1272	
Frequency of Operation	902 – 915 MHz	
Antenna Gain	+ 3 dBi	
FCC Classification	DSS	
Date Samples Received	10/18/2018	
Condition Samples Received	Suitable for test	
Sample Type	Production unit	
EUT Description	Connected Control Rodent Traps with LoRa Radio Communication	
Applicable FCC Rules	FCC Rules Part 15.247: Operation within the bands 902-928 MHz, 2400-2483.5 MHz and 5725-5850 MHz Direct Sequence System	
Applicable ISED Rules	RSS-Gen: General Requirements for Compliance of Radio Apparatus & RSS-247: Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices	



1.2 Preface

This report documents product testing conducted to verify compliance of the specified EUT with applicable standards and requirements as identified herein. EUT, test instrument configurations, test procedures, and recorded data are generally described in this report. The reader is referred to the applicable test standards for detailed procedures. The following table summarizes the test results obtained during this evaluation.

1.3 Laboratory and Customer Information

Test Laboratory Location	BEC Incorporated 970 East High Street Pottstown, PA 19464
Test Personnel	Paul Banker / Steve Fanella / JR Fanella
BEC Laboratory Number FCC Registration	US1118
BEC Laboratory Number ISED Registration	7342A-1
Test Performed For	Woodstream Corporation 69 North Locust Street Lititz, PA 17543
Customer Technical Contact	Dwayne Arrighy
Customer Reference Number	PO # 175123

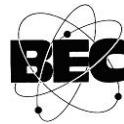
1.4 Measurement Uncertainty

Measurement	Measurement Distance	Frequency Range	Measurement Limit	Expanded Uncertainty
Radiated Disturbance	3 Meter	30 MHz – 1 GHz	Class B	4.57
Conducted Disturbance AC Mains	N/A	150 kHz – 30 MHz	Class A or B	3.43

No adjustments to measured data presented in this report are required because all values of uncertainty are less than the CISPR 16-4-2:2011 recommendations. These uncertainties have a coverage factor of $k = 2$, which yields approximately a 95% level of confidence for the near-normal distribution typical of most measurement results.

FCC Registered Test Site Number: US1118

ISED Registered Test Site Number: 7342A-1



1.5 Test Result Summary Table

The Woodstream Model V400M LoRa Radio Control Unit was tested to the following standards:

Report Section	FCC Part 15, Subpart C	IC RSS-Gen	IC RSS-247	Test Description	Result
N/A	15.207(b)	7.2		Conducted Emissions, AC 150 kHz to 30 MHz	N/A
4.1	15.203(b)	Annex A 10(g)		Antenna Requirement	PASS
4.3	15.205(a)	8.9	3.3	Restricted Bands of Operation 30 MHz to 10 GHz	PASS
4.4	15.209	8.10		Radiated Emissions, 30 MHz to 10GHz	PASS
4.5	15.247(a)(1)		5.1 c)	20 dB Occupied Bandwidth	PASS
4.6	15.247(a)(1)		5.1 c)	Carrier Frequency Separation	PASS
4.7	15.247(a)(1)(iii)		5.1 c)	Number of Hopping Frequencies	PASS
4.8	15.247(a)(1)(i)		5.1 c)	Time of Occupancy	PASS
4.9	15.247(b)(2)		5.4 a)	Maximum Peak Power Output and EIRP	PASS
4.10	15.247(d)		5.5	Band Edge Measurement	PASS
4.11	15.247(d)		5.5	Antenna Port, Conducted Spurious Emissions	PASS

Interpretation of Test Results: The EUT was tested using LoRa modulation. Also, the modulation scheme was tested in hopping and non-hopping modes as required by FCC and ICES rules. The resultant data is presented by showing the worst-case levels for each modulation type and/or frequency. All recorded results are maintained at BEC Inc.



1.6 Condition of Received Sample

An evaluation of the EUT was conducted in order to verify test subject identity and condition and to ensure suitability for testing. No evidence of physical damage was noted. The test item condition was deemed acceptable for the performance of the requested test services.

1.7 Climatic Environment

Unless noted elsewhere in this report, the following were the ambient conditions in the laboratory during testing:

Temperature: $22^{\circ} \pm 5^{\circ}$

Humidity: $50\% \pm 20\%$

Barometric Pressure: $1000\text{mb} \pm 20\%$

1.8 Test Equipment

All test equipment is checked to manufacturer's specifications and, when applicable, have current N.I.S.T. traceable, ISO 9002 conforming certificates of calibration. Test equipment used for the tests described herein is listed in Appendix A.



2.0 Equipment Under Test

Unless otherwise noted in the individual test results sections, testing was performed on the EUT as follows.

2.1 EUT Description

The Connected Rodent Control Trap utilizes a Woodstream Model V400M LoRa Radio Control Unit to communicate trap status to a smart phone or network application. The LoRa Radio Control Unit Model V400M can be used with either Model Number V450 Mouse Trap, or Model V460 Rat Trap Enclosure.

2.2 Product Category

FCC Part 15, Subpart C (Section 15.247), IC RSS-Gen, IC RSS-247

2.3 Product Classification

Intentional Radiator Testing Requirements DSS for Frequency Hopper Operation within the band of 902 - 928 MHz.

2.4 Test Configuration

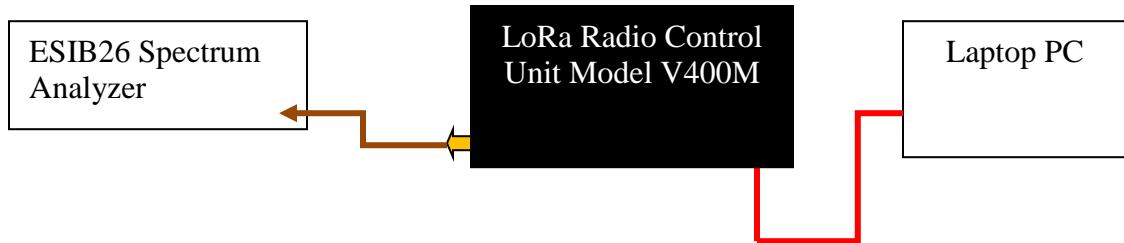
The Woodstream Model V400M LoRa Radio Control Unit Sample # 1908-05 was tested in both the small (Model V450) and large (Model V460) trap enclosures for all radiated emissions tests. The Woodstream Model V400M LoRa Radio Control Unit Sample # 1908-06 was tested without a trap enclosure for all antenna terminal measurements.

2.5 Test Configuration Rationale

The tested configurations are the two sizes of trap enclosures available by the manufacturer. The modified radio Control Unit allows direct access to the output of the radio, without a transmission antenna.

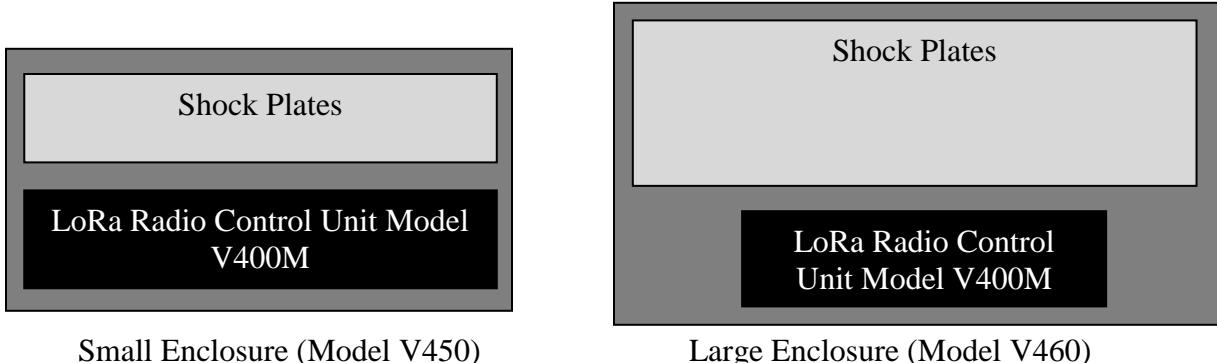
2.6 Test Configuration Diagram (Transmitter Conducted Measurements)

A block diagram of the EUT configuration showing interconnection cables is illustrated below. The drawing shows the physical hardware layout used for the tests along with I/O cables and AC power distribution.



2.7 Test Configuration Diagrams (Radiated Measurements)

A block diagram of the EUT configuration showing interconnection cables is illustrated below. The drawing shows the physical hardware layout used for the tests along with I/O cables and AC power distribution.





2.8 EUT Information, Interconnection Cabling and Support Equipment

EUT Hardware

Description	Manufacturer	Model	Serial Number	Sample Number
Lora Radio Control Unit (unmodified)	Woodstream Corporation	V400M	None	1908-05
Lora Radio Control Unit (modified with SMA)				1908-06

Interconnection Cable List (Conducted Test Setup)

Manufacturer	Model	Type	Shielding	Length	Description
Workhorse	WHU18-3636-036	High Frequency RF Cable 1 to 40 GHz	Double Braid	1 Meter	Measurement Cable from the Antenna SMA Connector to the Rohde and Schwarz ESIB26 Receiver. Asset # BEC-814

Support Equipment

Description	Manufacturer	Model	Serial Number
USB to Serial Port Adapter	Sparkfun	FTDI Basic	None
Lap Top Computer	Dell	PP04X	CN-OHN338-48643-84F-0307



2.9 Test Signals and Test Modulation

The following table lists the individual hopping frequencies for the transmitter. The EUT utilizes provide LoRa modulation. The frequency hopping could be enabled and modulated by selection. The transmitter also could be programmed to control the output at Low, Medium and Maximum Output levels.

Channel	Frequency	Channel	Frequency	Channel	Frequency	Channel	Frequency
	MHz		MHz		MHz		MHz
0	902.3	16	905.5	32	909.7	48	911.9
1	902.5	17	905.7	33	909.9	49	912.1
2	902.7	18	905.9	34	909.1	50	912.3
3	902.9	19	906.1	35	909.3	51	912.5
4	903.1	20	906.3	36	909.5	52	912.7
5	903.3	21	906.5	37	909.7	53	912.9
6	903.5	22	906.7	38	909.9	54	913.1
7	903.7	23	906.9	39	910.1	55	913.3
8	903.9	24	907.1	40	910.3	56	913.5
9	904.1	25	907.3	41	910.5	57	913.7
10	904.3	26	907.5	42	910.7	58	913.9
11	904.5	27	907.7	43	910.9	59	914.1
12	904.7	28	907.9	44	911.1	60	914.3
13	904.9	29	908.1	45	911.3	61	914.5
14	905.1	30	909.3	46	911.5	62	914.7
15	905.3	31	909.5	47	911.7	63	914.9

2.10 Grounding

There was no ground connection used; the EUT is battery powered and self-contained.

2.11 EUT Modifications

Except for the attachment of a SMA connector directly to the antenna output on the main board of the Woodstream Model V400M LoRa Radio Control Unit (Sample # 1908-06), no modifications were made to the EUT.



2.12 EUT Pictures Woodstream Model V400M LoRa Radio Control Unit and Enclosures

WOODSTREAM LORA RADIO CONTROL UNIT SAMPLE 1908-05 FRONT SIDE

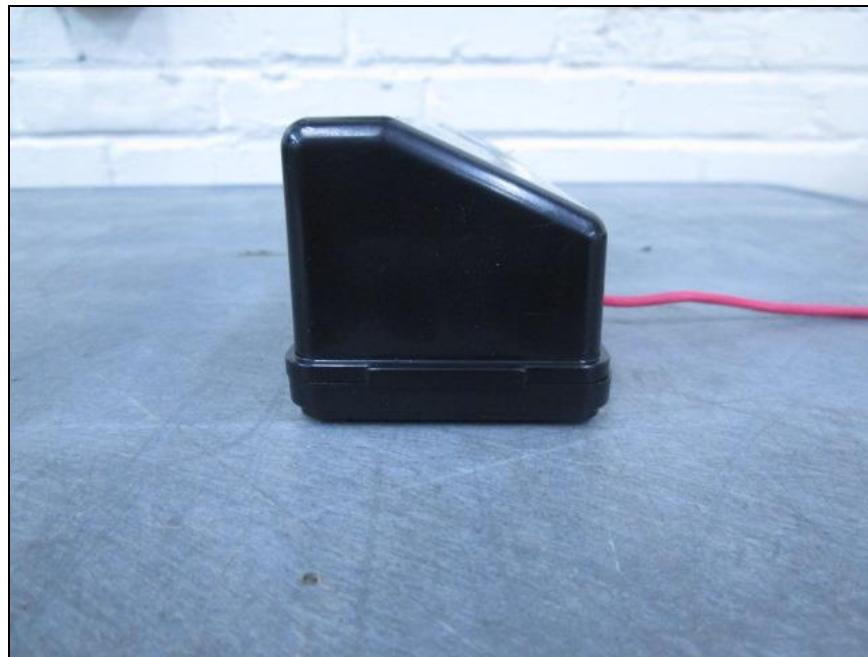


WOODSTREAM LORA RADIO CONTROL UNIT SAMPLE 1908-05 REAR SIDE





WOODSTREAM LORA RADIO CONTROL UNIT SAMPLE 1908-05 LEFT SIDE



WOODSTREAM LORA RADIO CONTROL UNIT SAMPLE 1908-05 RIGHT SIDE

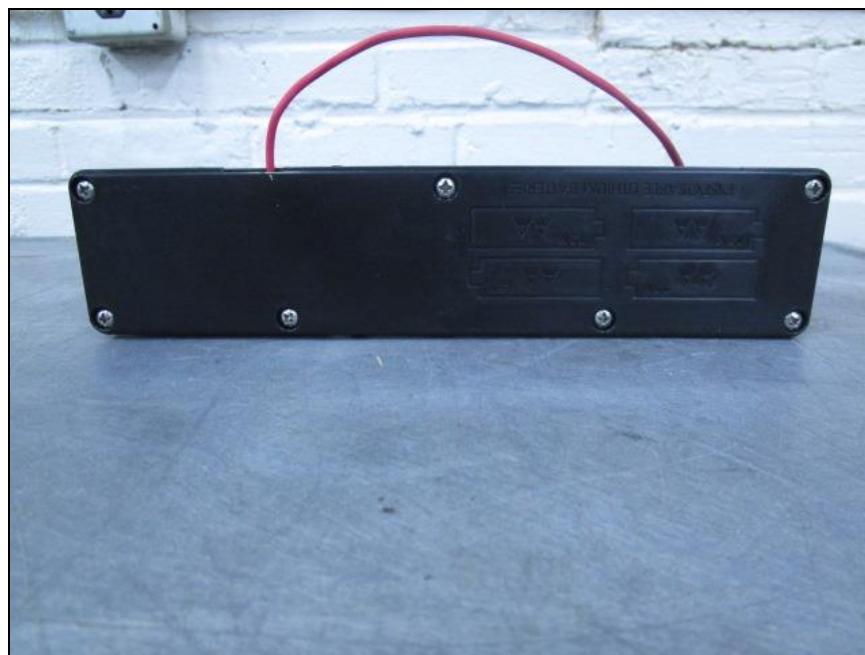




WOODSTREAM LORA RADIO CONTROL UNIT SAMPLE 1908-05 TOP SIDE



WOODSTREAM LORA RADIO CONTROL UNIT SAMPLE 1908-05 BOTTOM SIDE





WOODSTREAM LORA RADIO CONTROL UNIT SAMPLE 1908-06 TOP VIEW



WOODSTREAM LORA RADIO CONTROL UNIT SAMPLE 1908-06 LEFT SIDE VIEW



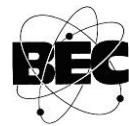


WOODSTREAM MOUSE TRAP ENCLOSURE MODEL V450 (LID CLOSED)



WOODSTREAM MOUSE TRAP ENCLOSURE MODEL V450 (LID OPENED)





WOODSTREAM MOUSE TRAP ENCLOSURE MODEL V450 (COMPONENTS)

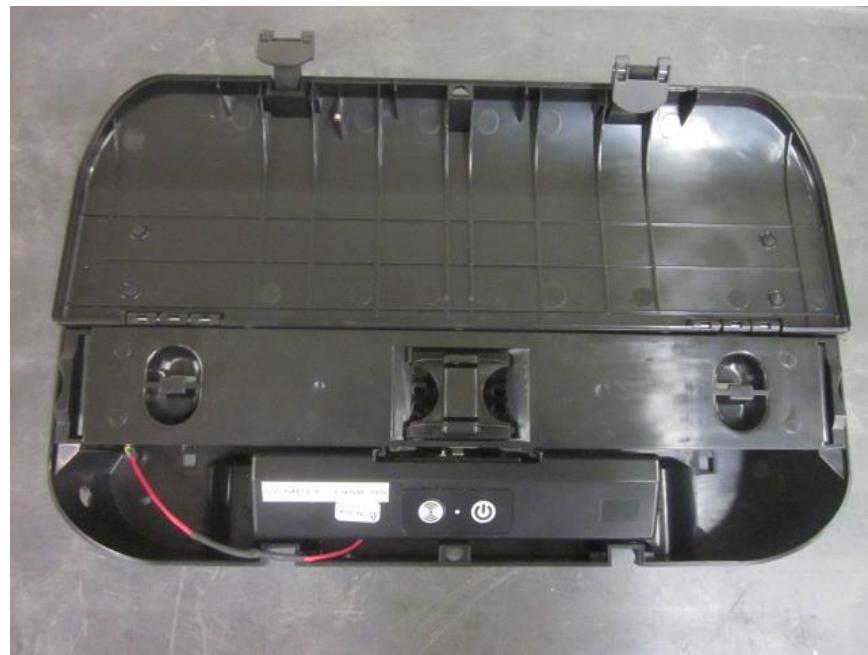


WOODSTREAM RAT TRAP ENCLOSURE MODEL V460 (LID CLOSED)





WOODSTREAM RAT TRAP ENCLOSURE MODEL V460 (LID OPENED)



WOODSTREAM RAT TRAP ENCLOSURE MODEL V460 (COMPONENTS)





3.0 Applicable Requirements, Methods, and Procedures

3.1 Applicable Requirements

The results of the measurement of the radio disturbance characteristics of the EUT described herein may be applied and where appropriate, provide a presumption of compliance to one or more of the following requirements or to other requirements at the discretion of the customer, regulatory agencies, or other entities.

3.1.1 FCC Requirements

Code of Federal Regulations: Title 47 – Telecommunication

Chapter I - Federal Communications Commission

Sub-chapter A – General

Part 15 – Radio Frequency Devices

Subpart C - Intentional Radiators

3.1.1 Industry Canada Requirements

RSS-Gen Issue 5: General Requirements for Compliance of Radio Apparatus

RSS-247 Issue 2: Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices

3.1.2 Basic Test Methods and Test Procedures

ANSI C63.4: 2014, American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.

FCC Public Notice FCC DA 00-705, Released March 30, 2000, “Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems.”

3.2 Deviations or Exclusions from the Requirements

No deviations or exclusions were made.



4.0 Test Results

4.1 Antenna Requirement (47 CFR 15.203)(RSS-GEN ANNEX A (10)(g))

The antenna used by the Woodstream Model V400M LoRa Radio Control Unit is a short trace on the main PCB of the EUT. There are no detachable parts of the antenna. The antenna is not replaceable, nor changeable, and therefore complies with the requirements of this section.

4.2 External RF power amplifiers and antenna modifications (47 CFR 15.204)(RSS-GEN 8.3)

There are no RF power amplifier kits available to be used with the Woodstream LoRa Radio Control Unit Model V400M. There are no detachable parts of the antenna. The antenna is not replaceable, nor changeable, and therefore complies with the requirements of this section.



4.3 Restricted Bands of Operation 30 MHz - 10 GHz (47 CFR 15.205 and RSS-Gen 8.10)

The emissions from the Woodstream Model V400M LoRa Radio Control Unit, which fall in the restricted bands of operation, detailed in this section, comply with the limits of 15.209. The EUT operated in its normal hopping mode. The Woodstream Model V400M LoRa Radio Control Unit was tested with each of the two enclosures; Model V450 and Model V460.

Measurement of the signals was performed with the EUT on a turntable and a variable height antenna mast at 3 meters distance. The signals residing in restricted bands of operation are listed in the tables below. The Woodstream Model V400M LoRa Radio Control Unit operated in normal hopping mode.

4.3.1 Restricted Bands of Operation 30 MHz – 1000 MHz (11/01/2018)

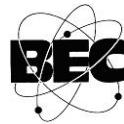
WOODSTREAM MODEL V400M IN THE SMALL ENCLOSURE (MODEL V450)

Frequency	Peak	QP	Polarity	TT angle	Ant Height	Correction Factors	RSS-Gen, FCC Class B Limit	Margin	Result
MHz	dBuV/m	dBuV/m	H/V	degrees	cm	dB	dBuV/m	dB	
136.668	13.13	12.54	V	231	177	-7.06	43.52	-30.98	PASS
167.002	13.16	12.25	H	067	230	-7.63	43.52	-31.27	PASS
171.079	14.98	15.49	H	001	201	-7.99	43.52	-28.03	PASS
988.348	18.95	17.13	V	253	132	-2.86	53.98	-36.85	PASS

WOODSTREAM MODEL V400M IN THE LARGE ENCLOSURE (MODEL V460)

Frequency	Peak	QP	Polarity	TT angle	Ant Height	Correction Factors	RSS-Gen, FCC Class B Limit	Margin	Result
MHz	dBuV/m	dBuV/m	H/V	degrees	cm	dB	dBuV/m	dB	
167.016	15.64	19.23	H	173	177	-7.63	43.52	-24.29	PASS
168.330	16.97	17.92	H	184	167	-7.74	43.52	-25.60	PASS
961.000	17.09	15.97	V	090	155	-3.19	53.98	-38.01	PASS

Test Results: The Woodstream Model V400M LoRa Radio Control Unit complies with the requirements of 47 CFR Part 15.205 and RSS-Gen Section 8.10 for restricted bands of operation.



4.3.2 Restricted Bands of Operation 1 – 10 GHz (11/02/2018)

WOODSTREAM MODEL V400M IN THE SMALL ENCLOSURE (MODEL V450)

Frequency	Peak	Average	Polarity	TT angle	Ant Height	Correction Factors	RSS-Gen, FCC Class B Limit	Margin	Result
GHz	dBuV/m	dBuV/m	H/V	degrees	cm	dB	dBuV/m	dB	
1.0002	30.92	20.85	V	360	143	-13.35	53.98	-33.13	PASS
1.0105	32.97	20.87	H	016	153	-13.28	53.98	-33.11	PASS
1.2160	30.18	21.53	H	303	102	-11.89	53.98	-32.45	PASS
2.7279	34.83	25.90	V	104	191	-3.26	53.98	-28.08	PASS
2.7340	35.84	26.82	H	029	147	-3.22	53.98	-27.16	PASS
4.7797	39.81	30.91	V	191	143	2.91	53.98	-23.07	PASS
4.7945	40.12	30.71	H	043	114	2.97	53.98	-23.27	PASS
8.2679	48.33	39.58	V	233	149	7.65	53.98	-14.40	PASS

WOODSTREAM MODEL V400M IN THE LARGE ENCLOSURE (MODEL V460)

Frequency	Peak	Average	Polarity	TT angle	Ant Height	Correction Factors	RSS-Gen, FCC Class B Limit	Margin	Result
GHz	dBuV/m	dBuV/m	H/V	degrees	cm	dB	dBuV/m	dB	
1.0002	30.03	20.85	V	092	171	-13.35	53.98	-33.13	PASS
1.0061	29.20	20.66	H	253	122	-13.31	53.98	-33.32	PASS
1.1732	29.83	20.23	V	326	166	-12.18	53.98	-33.75	PASS
1.6210	32.40	22.36	H	123	102	-9.18	53.98	-31.62	PASS
2.2378	33.68	24.13	H	163	131	-5.66	53.98	-29.85	PASS
2.7873	36.51	26.89	H	068	214	-2.93	53.98	-27.09	PASS
3.6341	38.32	28.92	H	293	104	0.58	53.98	-25.06	PASS
3.8821	39.20	29.52	V	099	158	1.37	53.98	-24.46	PASS
4.8107	40.47	30.85	H	022	110	3.03	53.98	-23.13	PASS
8.1664	49.44	39.63	H	291	135	7.53	53.98	-14.35	PASS
8.2281	48.21	39.40	V	041	117	7.60	53.98	-14.58	PASS
9.1285	49.06	39.80	V	280	148	8.83	53.98	-14.18	PASS

Test Results: The Woodstream Model V400M LoRa Radio Control Unit complies with the requirements of 47 CFR Part 15.205 and RSS-Gen Section 8.10.

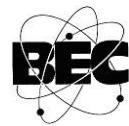
4.3.3 Restricted Bands of Operation and Spurious Emissions Radiated Test Setup Pictures

Small Enclosure (Model V450 With Model V400M) 30 – 1000 MHz Test Setup



Large Enclosure (Model V460 With Model V400M) 30 – 1000 MHz Test Setup

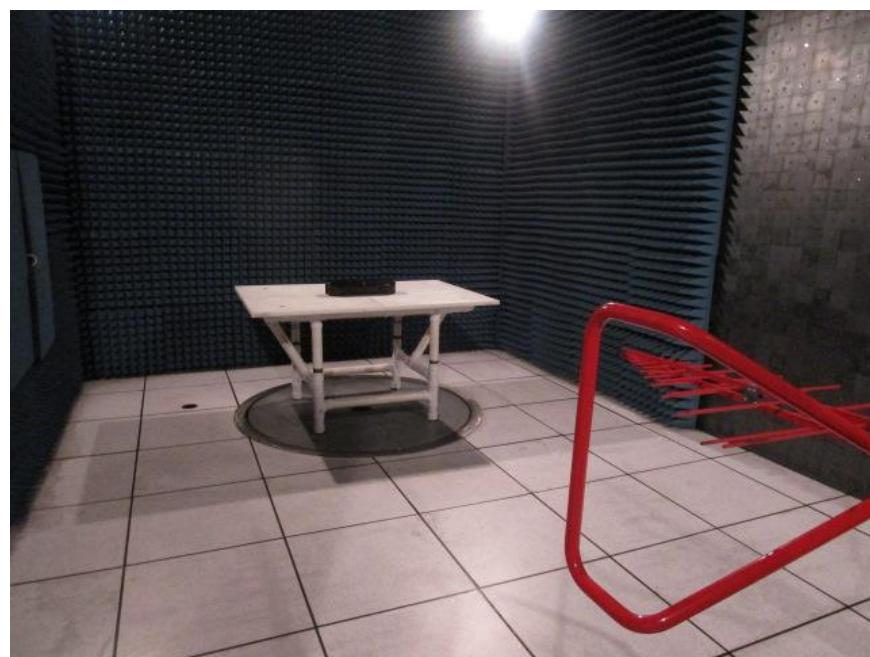




Small Enclosure (Model V450 With Model V400M) 30 – 1000 MHz Test Setup



Large Enclosure (Model V460 With Model V400M) 30 – 1000 MHz Test Setup

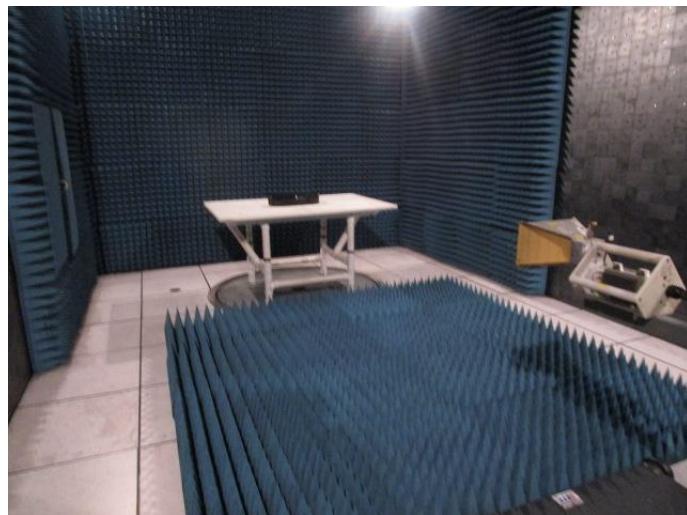




Small Enclosure (Model V450 With Model V400M) 1 – 10 GHz Test Setup



Large Enclosure (Model V460 With Model V400M) 1 – 10 GHz Test Setup





4.4 Radiated Emissions 30 MHz – 10 GHz (47 CFR 15.209(a) and RSS-Gen 8.10)

SR#1

The Semi-Anechoic Shielded Room (SR#1) is an ferrite and absorber lined chamber which houses a 5-foot diameter turntable capable of rotating equipment 360 degrees and antenna mast for Horizontal and Vertical polarity measurements. The enclosure is free of reflective metallic objects and extraneous electromagnetic signals. This 3 meter shielded enclosure has a raised computer floor with metal tile bottoms providing a continuous ground plane.

Instrumentation for remote control of the antenna mast, turntable, and other equipment are controlled by personnel outside the chamber. The EUT and support peripherals required for EUT operation were placed on a table 80 cm high for tabletop equipment or directly on the turntable surface for floor standing equipment.

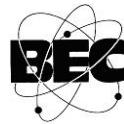
The test site complies with the attenuation measurements specified in ANSI C63.4:2014

Radiated Emissions 30MHz – 10 GHz

The EMI receiver was set to quasi-peak mode for frequencies from 30MHz to 1GHz and the appropriate CISPR bandwidths were employed. The receiver was set to average mode for frequencies above 1GHz with the appropriate CISPR bandwidths were employed. Significant emissions found during the preliminary scans were maximized by rotating the turntable and varying the antenna height. Both horizontal and vertical antenna polarities were also investigated for suspect emissions. The signals are maximized and measured using the in house generated RADE or off the shelf TILE software. The support equipment and test item(s) were powered off in turn to determine the source of the emissions where appropriate.

Field strengths were calculated as follows:

Field Strength (dB μ V/m) = Meter Reading (dB μ V) + Antenna Factor (dB/m) + Cable Loss (dB) – Amplifier Gain (dB)



4.4.1 Spurious Radiated Emissions 30 M – 1 GHz Measurement (11/01/2018 and 11/02/2018)

The spurious signal measurements made between 30 MHz and 1 GHz are listed below, those signals which are contained in a restricted band are also displayed in Section 4.3.1.

WOODSTREAM MODEL V400M IN THE SMALL ENCLOSURE (MODEL V450)

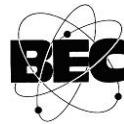
Frequency MHz	Peak dBuV/m	QP dBuV/m	Polarity H/V	TT angle degrees	Ant Height cm	Correction Factors dB	RSS-Gen, FCC Class B Limit dBuV/m	Margin dB	Results
30.626	20.51	19.04	V	349	132	-0.83	40.00	-20.96	PASS
30.629	20.77	19.04	H	147	219	-0.83	40.00	-20.96	PASS
66.848	9.67	12.57	V	048	133	-12.77	40.00	-27.43	PASS
136.668	13.13	12.54	V	231	177	-7.06	43.52	-30.98	PASS
167.002	13.16	12.25	H	067	230	-7.63	43.52	-31.27	PASS
171.079	14.98	15.49	H	001	201	-7.99	43.52	-28.03	PASS
175.994	19.02	21.35	H	208	189	-8.33	43.52	-22.17	PASS
179.129	13.75	12.37	H	231	100	-8.51	43.52	-31.15	PASS
182.769	14.26	17.65	H	007	202	-8.62	43.52	-25.87	PASS
182.921	26.78	11.76	H	263	104	-8.64	43.52	-31.76	PASS
191.239	15.13	16.65	H	217	114	-8.20	43.52	-26.87	PASS
191.988	19.96	22.14	H	247	156	-8.12	43.52	-21.38	PASS
196.309	14.30	12.72	V	281	178	-7.54	43.52	-30.80	PASS
198.036	13.33	13.68	H	075	191	-7.19	43.52	-29.84	PASS
363.804	16.18	12.08	V	089	252	-7.65	46.02	-33.94	PASS
375.874	16.98	13.46	H	193	168	-7.60	46.02	-32.56	PASS
376.672	14.73	13.58	H	177	184	-7.61	46.02	-32.44	PASS
380.178	17.10	13.92	H	233	241	-7.65	46.02	-32.10	PASS
383.905	16.14	13.66	H	197	224	-7.58	46.02	-32.36	PASS
388.238	14.46	13.03	H	197	109	-7.57	46.02	-32.99	PASS
470.513	14.93	13.05	V	043	126	-7.68	46.02	-32.97	PASS
506.473	15.03	13.65	V	215	100	-6.88	46.02	-32.37	PASS
510.020	17.91	13.81	V	104	196	-6.75	46.02	-32.21	PASS
513.958	14.62	14.14	V	071	110	-6.66	46.02	-31.88	PASS
518.678	17.43	14.11	V	102	121	-6.55	46.02	-31.91	PASS
631.293	17.47	14.88	V	072	121	-5.65	46.02	-31.14	PASS
720.196	17.28	15.37	V	111	126	-5.09	46.02	-30.65	PASS
847.710	15.70	15.63	V	174	201	-4.08	46.02	-30.39	PASS
959.270	15.21	16.00	V	003	248	-3.21	46.02	-30.02	PASS
988.348	18.95	17.13	V	253	132	-2.86	53.98	-36.85	PASS



WOODSTREAM MODEL V400M IN THE LARGE ENCLOSURE (MODEL V460)

Frequency	Peak	QP	Polarity	TT angle	Ant Height	Correction Factors	RSS-Gen, FCC Class B Limit	Margin	Results
MHz	dBuV/m	dBuV/m	H/V	degrees	cm	dB	dBuV/m	dB	
30.775	21.94	18.96	H	223	202	-0.90	40.00	-21.04	PASS
31.778	17.54	18.23	V	360	247	-1.70	40.00	-21.77	PASS
148.992	14.89	13.87	V	222	207	-7.19	43.52	-29.65	PASS
151.482	12.06	12.68	V	053	150	-7.17	43.52	-30.84	PASS
158.810	14.96	13.10	V	277	156	-7.12	43.52	-30.42	PASS
159.967	19.94	18.67	V	114	115	-7.21	43.52	-24.85	PASS
159.997	25.96	25.04	H	199	195	-7.21	43.52	-18.48	PASS
167.016	15.64	19.23	H	173	177	-7.63	43.52	-24.29	PASS
168.330	16.97	17.92	H	184	167	-7.74	43.52	-25.60	PASS
176.002	23.12	21.77	H	317	121	-8.33	43.52	-21.75	PASS
177.086	18.46	16.12	H	168	179	-8.43	43.52	-27.40	PASS
179.577	11.29	11.52	V	114	120	-8.55	43.52	-32.00	PASS
180.869	13.51	11.78	V	242	172	-8.58	43.52	-31.74	PASS
183.406	13.43	11.18	V	298	184	-8.64	43.52	-32.34	PASS
184.268	13.88	12.14	H	135	110	-8.62	43.52	-31.38	PASS
191.986	17.27	14.17	H	239	121	-8.12	43.52	-29.35	PASS
195.801	15.77	14.08	H	165	109	-7.63	43.52	-29.44	PASS
204.562	15.68	12.77	V	100	127	-7.19	43.52	-30.75	PASS
212.929	13.23	11.76	H	035	178	-7.74	43.52	-31.76	PASS
213.374	13.31	12.39	H	001	154	-7.78	43.52	-31.13	PASS
570.590	18.40	14.30	V	231	114	-6.04	46.02	-31.72	PASS
575.461	15.09	13.95	V	317	150	-6.00	46.02	-32.07	PASS
594.046	15.28	13.91	V	279	173	-5.83	46.02	-32.11	PASS
594.502	15.64	14.75	H	348	178	-5.82	46.02	-31.27	PASS
601.623	16.42	14.44	H	358	104	-5.79	46.02	-31.58	PASS
606.964	16.61	14.43	V	238	100	-5.78	46.02	-31.59	PASS
614.302	16.43	14.85	V	022	138	-5.76	46.02	-31.17	PASS
959.005	18.06	15.99	H	099	247	-3.21	46.02	-30.03	PASS
961.000	17.09	15.97	V	090	155	-3.19	53.98	-38.01	PASS

Test Results: The Woodstream Model V400M LoRa Radio Control Unit complies with the requirements of 47 CFR Part 15.209 and RSS-Gen Section 8.10 with a margin of 18.48 dB.



4.4.2 Radiated Emissions 1 – 10 GHz Measurement (11/02/2018)

The spurious signal measurements made between 30 MHz and 1 GHz are listed below, those signals which are contained in a restricted band are also displayed in Section 4.3.2.

WOODSTREAM MODEL V400M IN THE SMALL ENCLOSURE (MODEL V450)

Frequency	Peak	Average	Polarity	TT angle	Ant Height	Correction Factors	RSS-Gen, FCC Class B Limit	Margin	Result
GHz	dBuV/m	dBuV/m	H/V	degrees	cm	dB	dBuV/m	dB	
1.8283	32.65	23.47	V	002	164	-7.82	53.98	-30.51	PASS
2.7279	34.83	25.90	V	104	191	-3.26	53.98	-28.08	PASS
2.7340	35.84	26.82	H	029	147	-3.22	53.98	-27.16	PASS

WOODSTREAM MODEL V400M IN THE LARGE ENCLOSURE (MODEL V460)

Frequency	Peak	Average	Polarity	TT angle	Ant Height	Correction Factors	RSS-Gen, FCC Class B Limit	Margin	Result
GHz	dBuV/m	dBuV/m	H/V	degrees	cm	dB	dBuV/m	dB	
3.6341	38.32	28.92	H	293	104	0.58	53.98	-25.06	PASS
8.2281	48.21	39.40	V	041	117	7.60	53.98	-14.58	PASS
9.1285	49.06	39.80	V	280	148	8.83	53.98	-14.18	PASS

Test Results: The Woodstream Model V400M LoRa Radio Control Unit complies with the requirements of 47 CFR Part 15.209 and RSS-Gen 8.10.

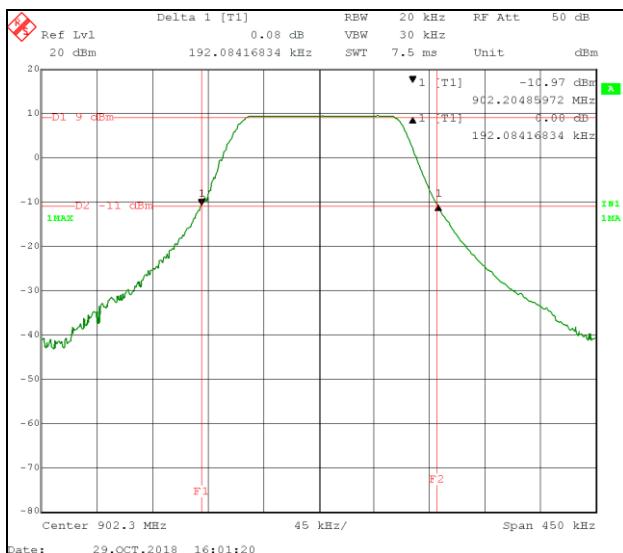
4.4.3 Radiated Emissions Test Setup Pictures

The photographs of the test setups for radiated emissions are the same as 4.3.3.

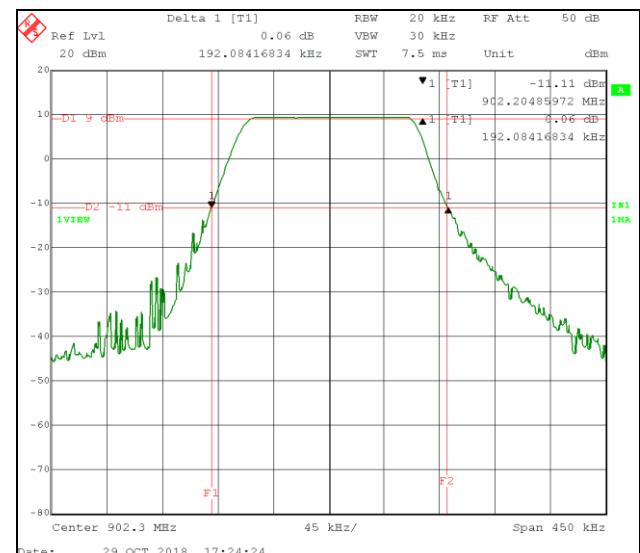
4.5 20 dB Bandwidth Measurement 47 CFR 15.247(a)(1) and RSS-247 Section (5.1)(c) (10/29/2018)

The Woodstream Model V400M LoRa Radio Control Unit was connected to a spectrum analyzer, through the SMA connector attached to the transmitter output. Measurements were made at low, middle and high channels at the lowest and highest Spread Factor options of LoRa Modulation. The transmitter was set to its highest output level.

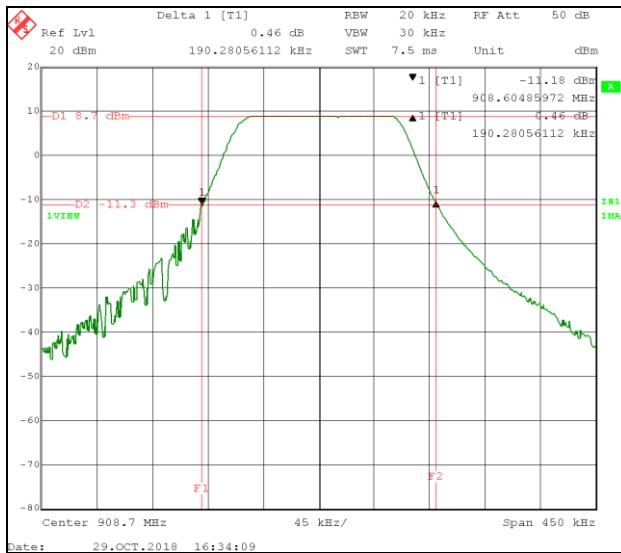
Channel	Spread Factor	Frequency	Measured 20 dB Bandwidth	RSS-247 5.1.3, FCC 15.247 20 dB BW Limit	Margin
		MHz	kHz	kHz	kHz
0	7	902.3	192.08	500	-307.92
32		908.7	190.28		-309.72
63		914.9	191.18		-308.82
0		902.3	192.08		-307.92
32		908.7	190.28		-309.72
63		914.9	191.18		-308.82



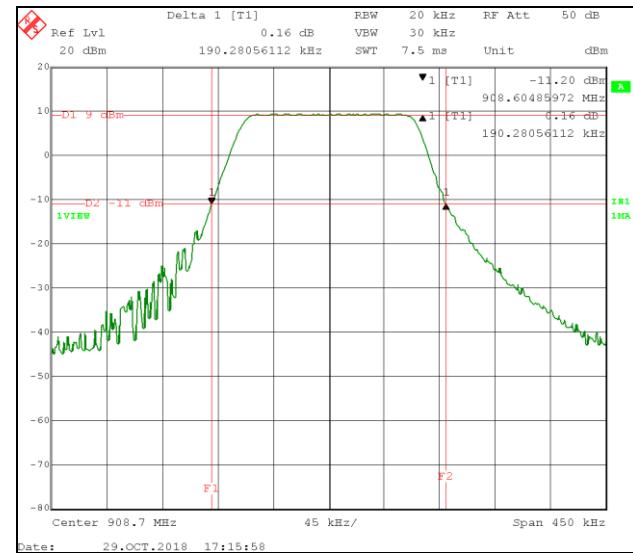
Channel 0, Spread = 7



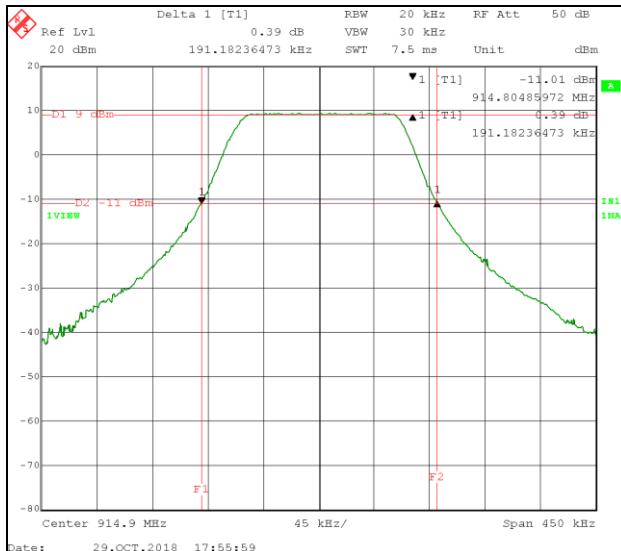
Channel 0, Spread = 12



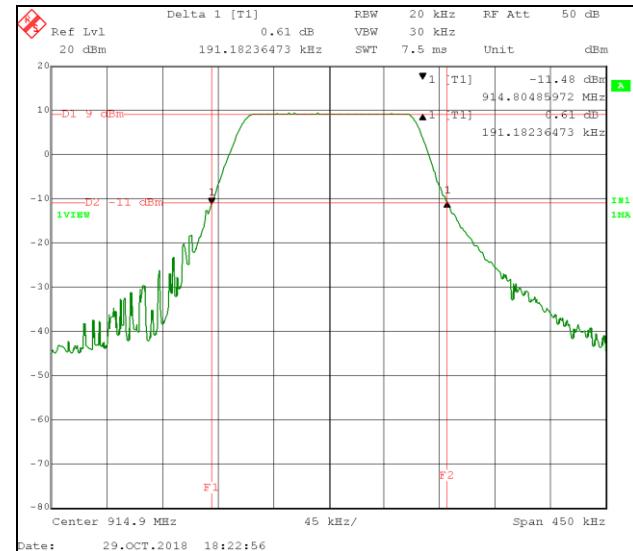
Channel 32, Spread = 7



Channel 32, Spread = 12



Channel 63, Spread = 7



Channel 63, Spread = 12

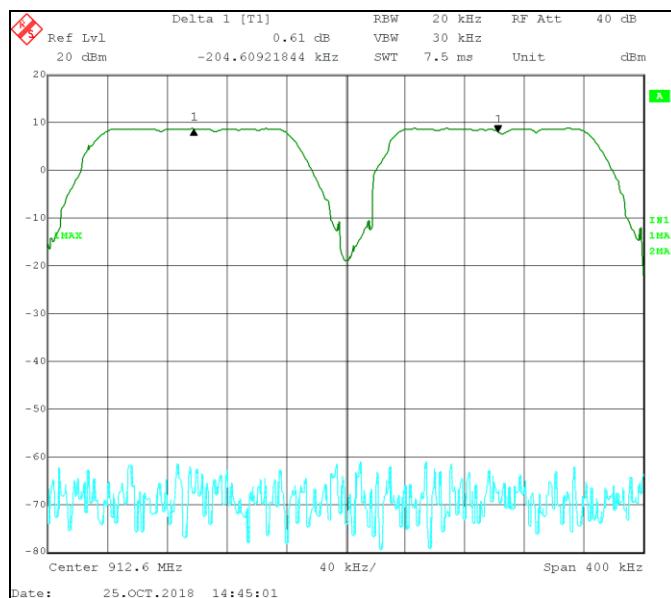
Test Results: The Woodstream Model V400M LoRa Radio Control Unit complies with the requirements of 47 CFR Part 15.247 (1) (a) and RSS-247 Section 5.1.3. Measurements made at low, middle and high channels, at minimum and maximum Spread Factors are compliant to the 500 kHz limit for 20 dB bandwidth.



4.6 Carrier Frequency Separation 47 CFR 15.247(a)(1) RSS-247 (5.1)(c) (10/25/2018)

Hopping Channels must be separated by a minimum of 25 kHz or the 20 dB bandwidth whichever is greater.

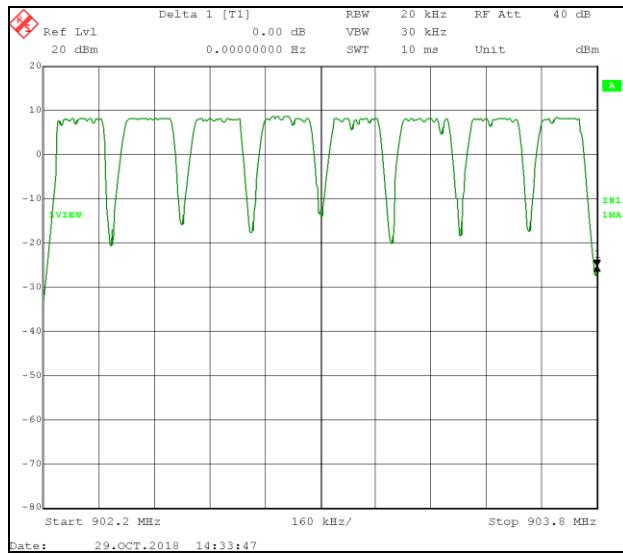
Hopping Channel	Channel Frequency	Channel Separation (Marker 1 - Delta)	Minimum Separation (20 dB Bandwidth)	Margin
#	MHz	kHz	kHz	kHz
51	912.5			
52	912.7	204.6	192.08	12.52



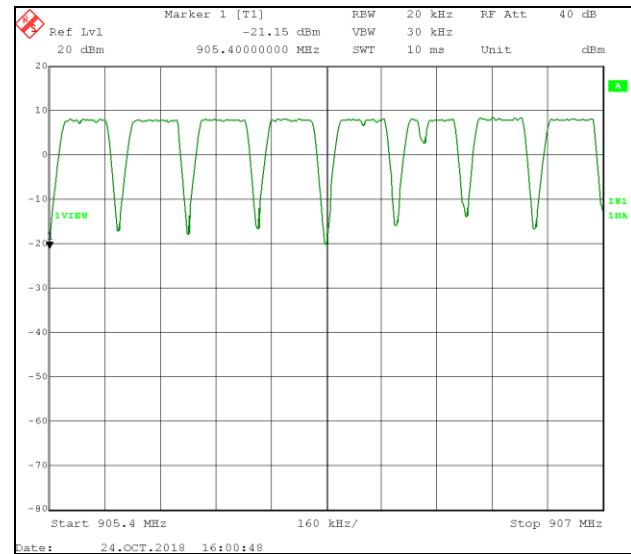
Test Results: The spacing between adjacent, hopping, channels of the Woodstream Model V400M LoRa Radio Control Unit are 204.6 kHz. This value is greater than the minimum separation of 192.08 kHz (20 dB bandwidth). 47 CFR Part 15.247 (a) (1) specifies a channel separation greater than 25 kHz or the 20 dB Bandwidth, whichever is greater. The Woodstream Model V400M LoRa Radio Control Unit complies with the requirement.

4.7 Number of Hopping Frequencies 47 CFR 15.247(a)(1)(iii), RSS-247 (5.1)(c) (10/24/2018, 10/25/2018 & 10/29/2018)

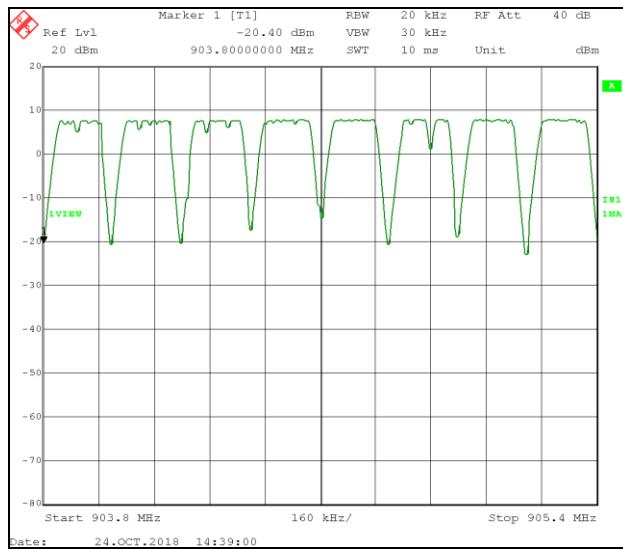
Section 2.9 contains the table of 64 hopping frequencies used by the Woodstream Model V400M LoRa Radio Control Unit. The Spectrum Analyzer screens below show the hopping frequencies in a Max Hold function.



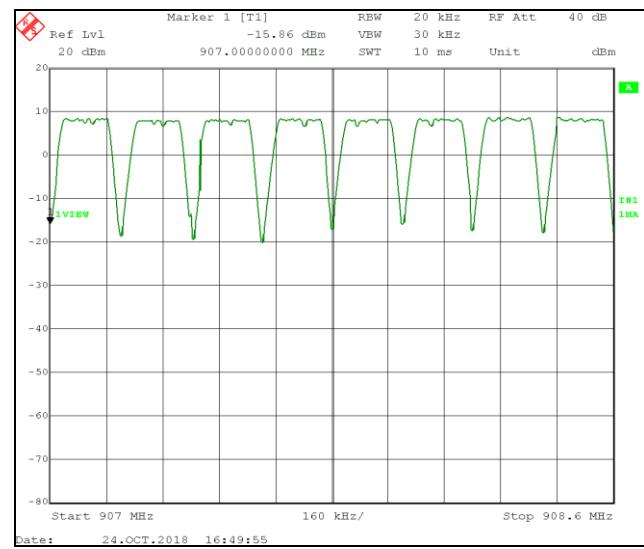
Channels 0 – 7 (902.3 – 903.7 MHz)



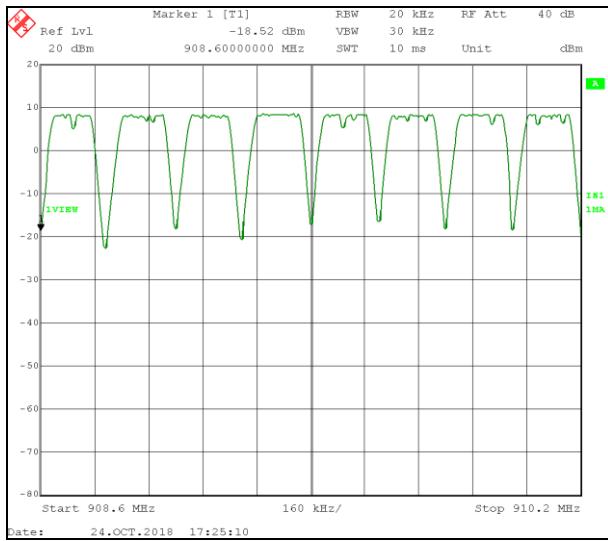
Channels 16 – 23 (905.5 – 906.9 MHz)



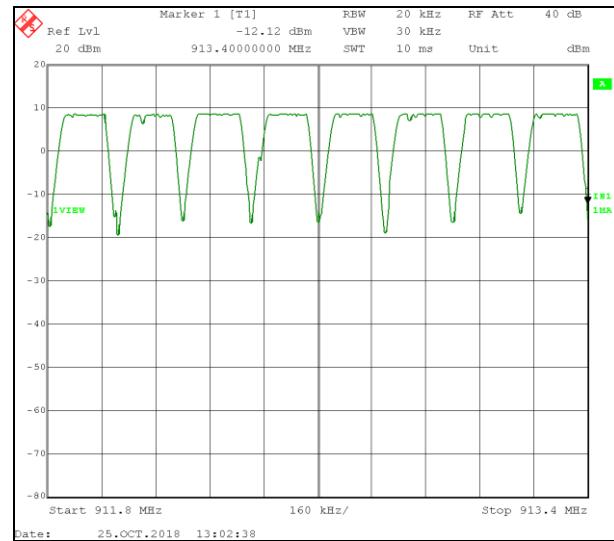
Channels 8 – 15 (903.9 – 906.3 MHz)



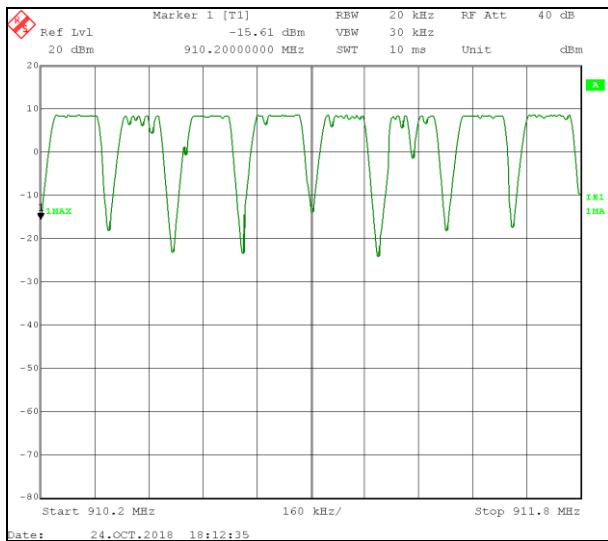
Channels 24 – 31 (907.1 – 908.5 MHz)



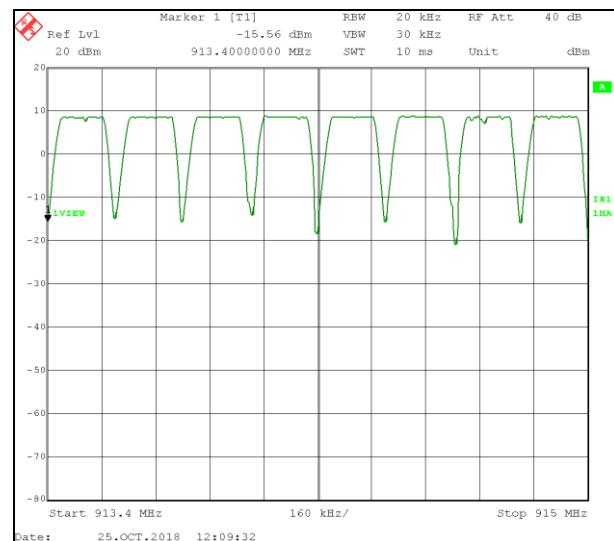
Channels 32 – 39 (908.7 – 910.1 MHz)



Channels 48 – 55 (911.9 – 913.3 MHz)



Channels 40 – 47 (910.3 – 911.7 MHz)



Channels 56 – 63 (913.5 – 914.9 MHz)

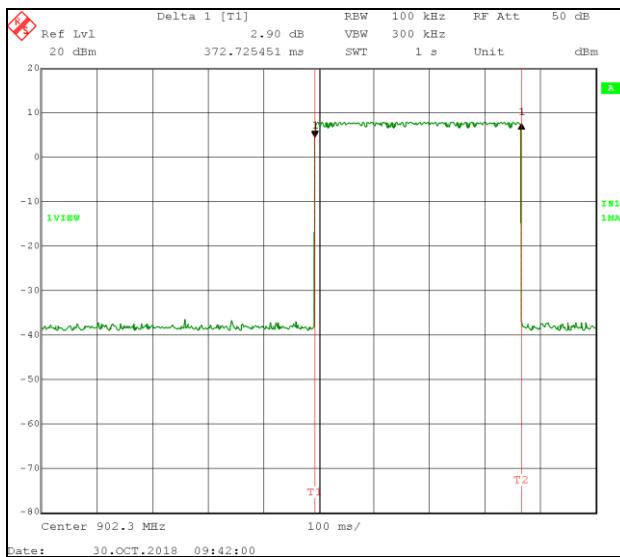
Test Results: The number of hopping channels, 64, complies with the requirement of 47 CFR Part 15.247(a) (1) (i) by using at least 50 hopping channels for a device with a 20 dB bandwidth less than 250 kHz.



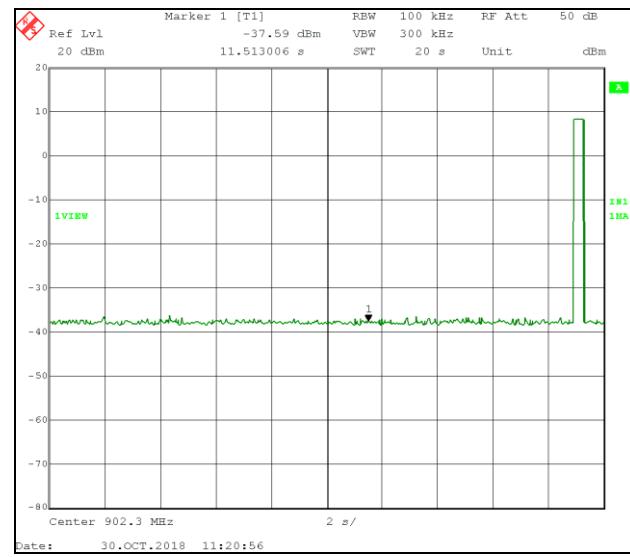
4.8 Time of Occupancy (Dwell Time) 47 CFR 15.247(a)(1)(i) RSS-247 (5.1)(c) (10/30/2018)

Section (a)(1)(iii) of 15.247 requires the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. Below are spectrum analyzer screens at low, middle and high frequencies that demonstrate the dwell time and period. LoRa Modulation Spread Factor value had no effect on Time of Occupancy.

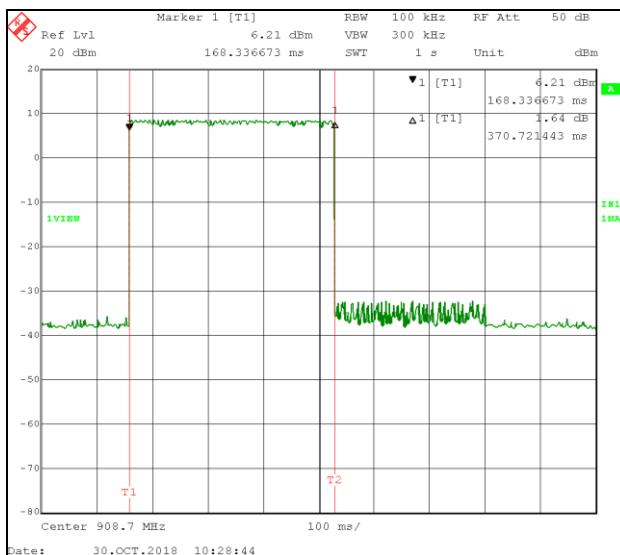
Channel	LoRa Mod Spread Factor	Freq (MHz)	Dwell Time (msec)	Limit (msec)	Margin (msec)
0	12	902.3	372.72	400	-27.28
32		908.7	370.72	400	-29.28
63		914.9	370.72	400	-29.28



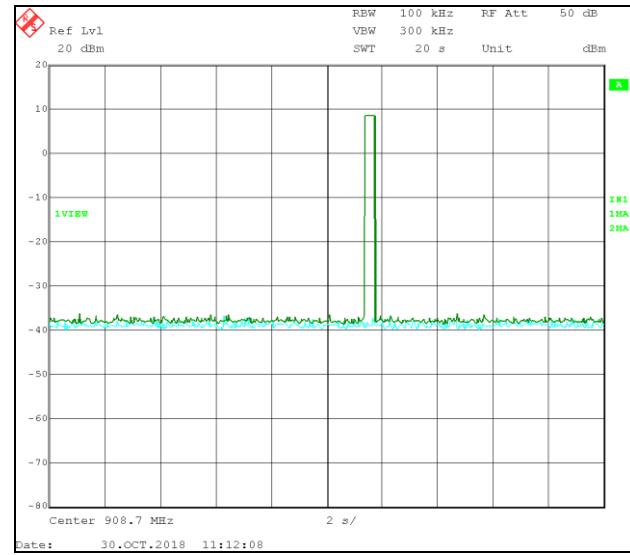
Channel 0, 902.3 MHz Dwell



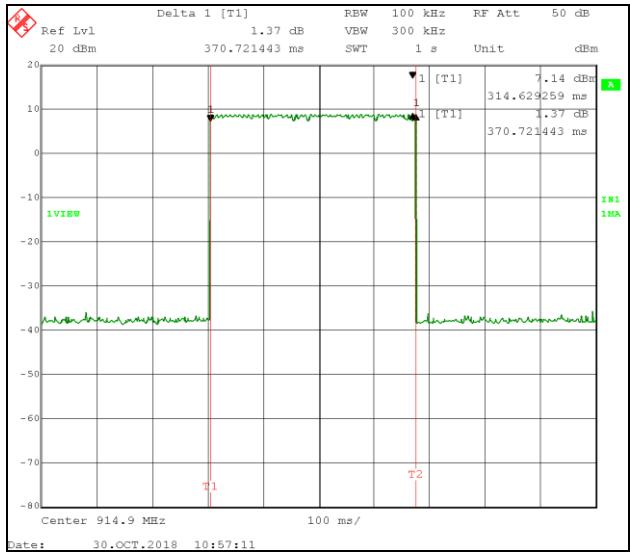
Channel 0, 902.3 MHz period



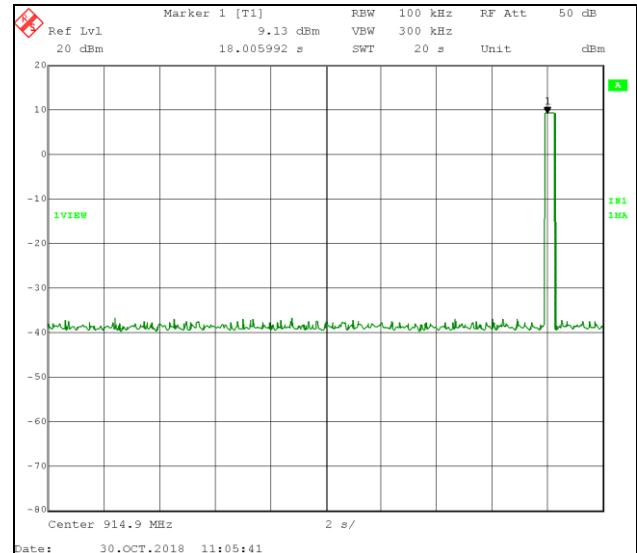
Channel 32, 908.7 MHz Dwell



Channel 32, 908.7 MHz Period



Channel 64, 914.9 MHz Dwell



Channel 64, 914.9 MHz Period

Test Results: The average dwell time is less than 400 msec and the period is greater than 10 seconds. The Woodstream Model V400M LoRa Radio Control Unit is compliant to the required parameters of 47 CFR Part 15.247 (a) (1) (i).

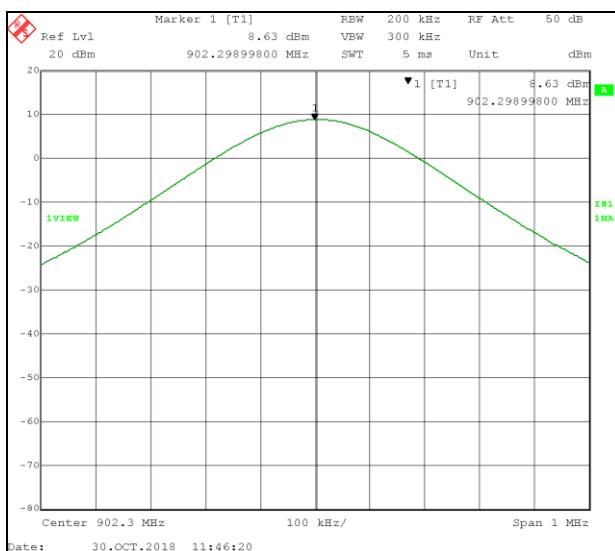
4.9 Maximum Peak Power Output and EIRP, 47 CFR 15.247(b)(2) RSS-247 (5.4)(a) (10/30/2018)

Measurements of the Maximum Peak Power Output of the Woodstream Model V400M LoRa Radio Control Unit were made with the spectrum analyzer connected directly to the transmitter output in place of the antenna. The table contains the power levels for modulation schemes at low, middle and high frequencies.

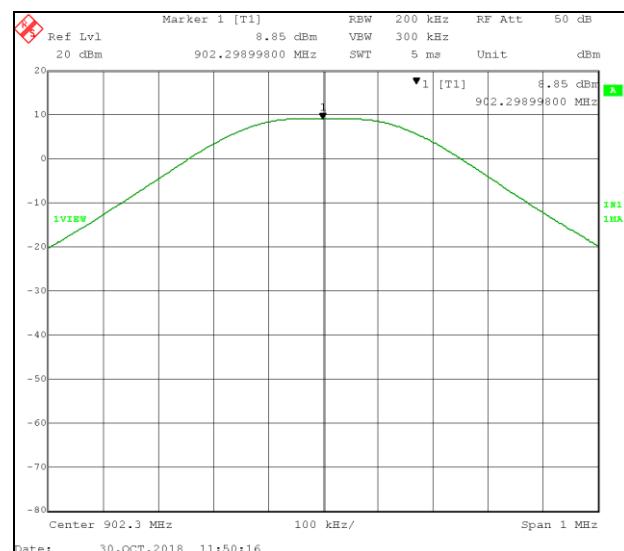
	Frequency (MHz)	Measured Level (dBm)	Cable # 814 Loss (dB)	Total		Limit		Margin	
				dBm	Watts	dBm	Watts	dBm	Watts
Unmodulated Carrier	902.3	8.63	0.37	9.00	0.008	30.00	1.000	-21.00	-0.992
	908.7	8.72	0.38	9.10	0.008	30.00	1.000	-20.90	-0.992
	914.9	8.85	0.38	9.23	0.008	30.00	1.000	-20.77	-0.992
LoRa	902.3	8.85	0.37	9.22	0.008	30.00	1.000	-20.78	-0.992
	908.7	8.57	0.38	8.95	0.008	30.00	1.000	-21.05	-0.992
	914.9	8.48	0.38	8.86	0.008	30.00	1.000	-21.14	-0.992

The gain of the antenna, used in the Woodstream Model V400M LoRa Radio Control Unit is 3.0 dB. Applying the antenna gain to the maximum transmitter output produces the following values of EIRP.

	Frequency (MHz)	Transmitter Output Total		Antenna Gain		EIRP		EIRP Limit	Margin
		dBm	Watts	Isotropic	Numeric	dBm	Watts	Watts	Watts
Unmodulated Carrier	902.3	9.00	0.0079	3.00	1.995	12.00	0.000	4.00	-4.000
	908.7	9.10	0.0081	3.00	1.995	12.10	0.000	4.00	-4.000
	914.9	9.23	0.0084	3.00	1.995	12.23	0.000	4.00	-4.000
LoRa	902.3	9.22	0.0084	3.00	1.995	12.22	0.000	4.00	-4.000
	908.7	8.95	0.0079	3.00	1.995	11.95	0.000	4.00	-4.000
	914.9	8.86	0.0077	3.00	1.995	11.86	0.000	4.00	-4.000



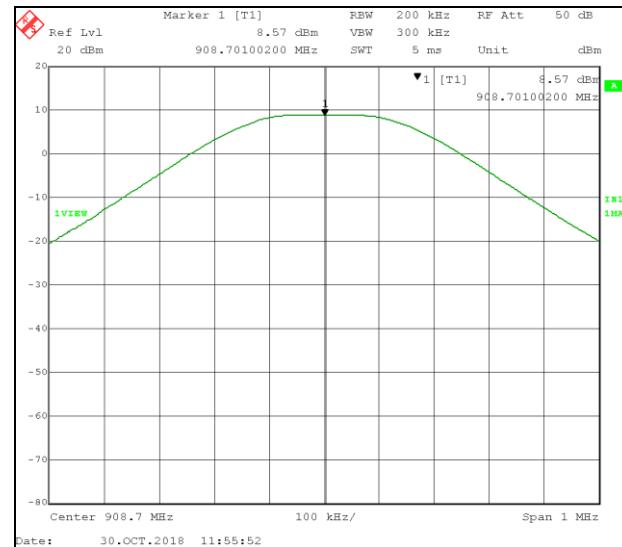
Channel 0, 902.3 MHz Unmodulated



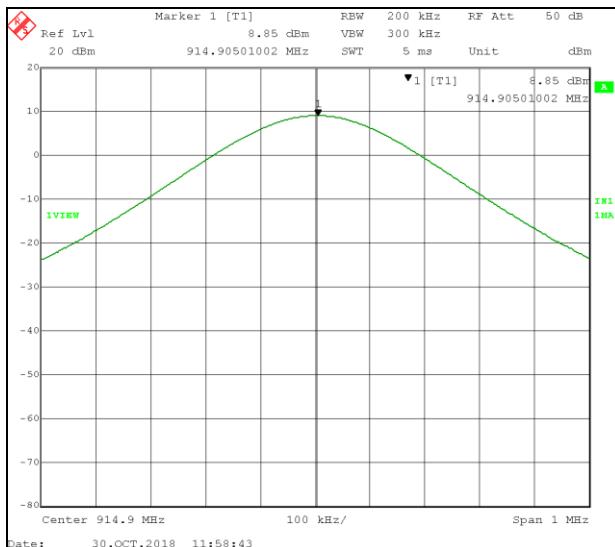
Channel 0, 902.3 MHz, LoRa Modulation



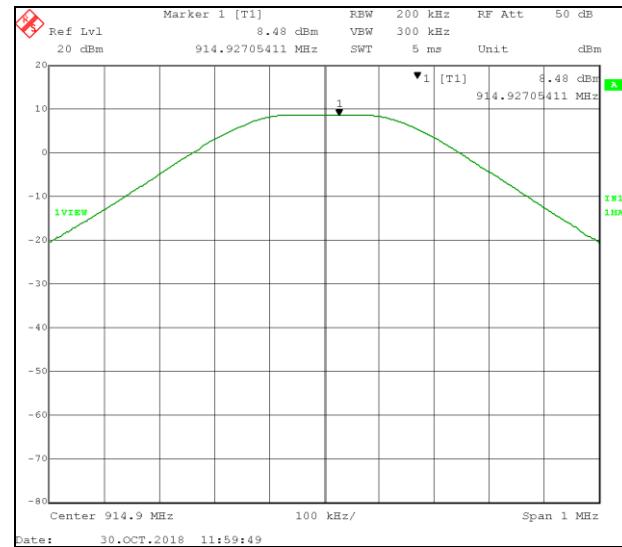
Channel 32, 908.7 MHz Unmodulated



Channel 32, 908.7 MHz, LoRa Modulation



Channel 64, 914.9 MHz, Un-modulated

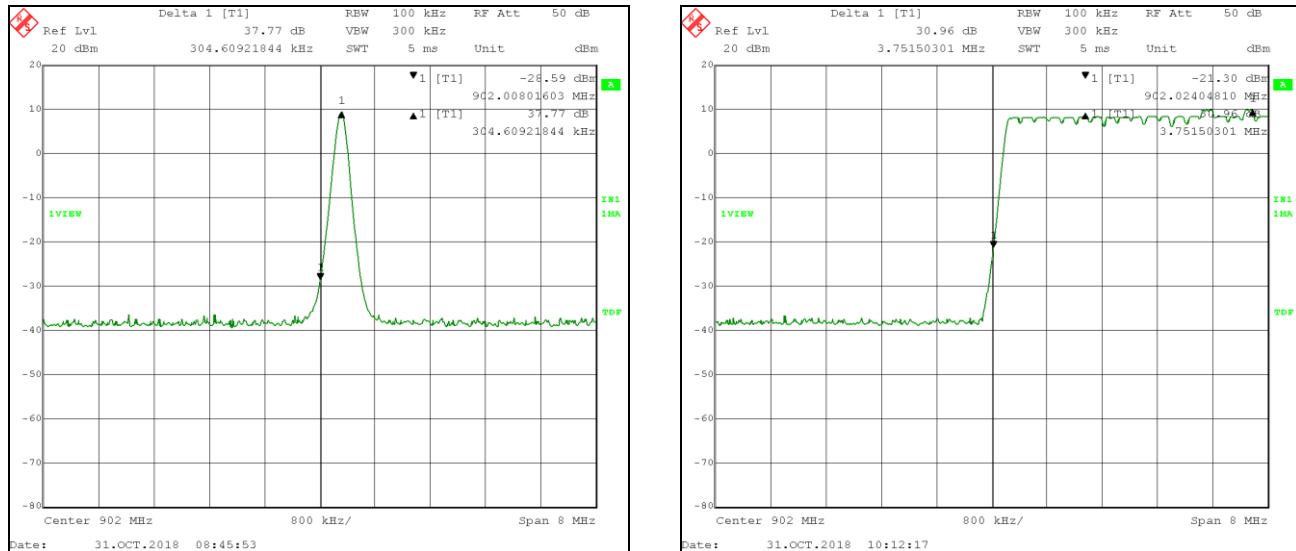


Channel 64, 914.9 MHz, LoRa Modulation

Test Results: The peak output power of the Woodstream Model V400M LoRa Radio Control Unit varied .37 dB between channels and modulations. The highest levels were measured unmodulated at Channel 64 and LoRa modulated at Channel 0. The maximum peak power output level was compliant to the 1 Watt limit imposed by 47 CFR Part 15.247 (b) (2).

4.10 Band Edge Measurement 47 CFR 15.247(d) and RSS-247 (5.5) (10/31/2018)

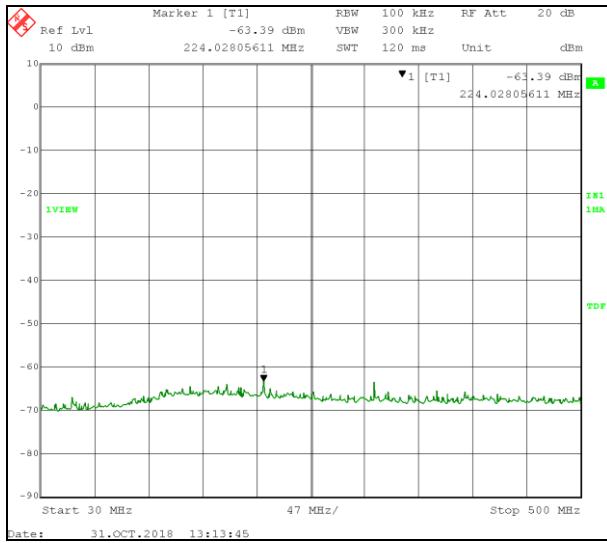
The demonstration of band-edge compliance is shown by two spectrum analyzer screens. The SA bandwidth is 100 kHz. The left screen shows the channel 0 (not hopping), with center frequency of 903 MHz displayed with spectrum analyzer centered on 902 MHz, the lower operational band frequency. The left screen is a wider span with channels hopping.



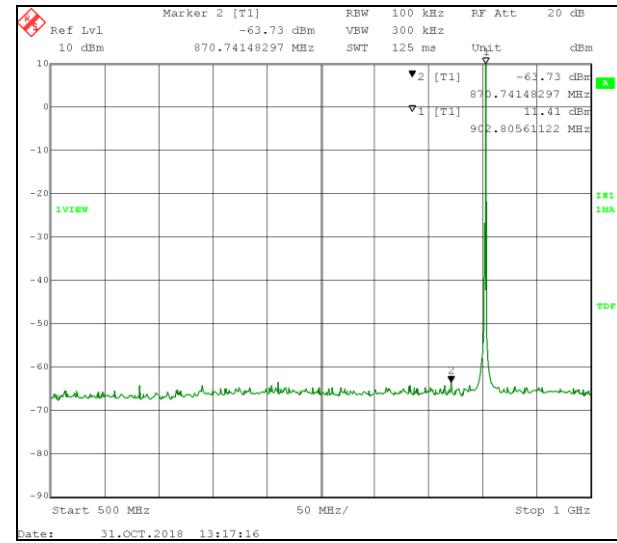
Test Results: The level of highest emission occurs at 902 MHz on both screens. The level of emission on the left screen is 37.77 dB down from the peak of the channel signal. The level of emission on the right screen is 30.96 down from the peak of the hopping channels. The Woodstream Model V400M LoRa Radio Control Unit demonstrates that emissions measured with a 100 kHz band, outside the operating band are more than 20 dB below the 100 kHz bandwidth emission inside the operating band. This complies with the requirements of 47 CFR Part 15.247(d).

4.11 Spurious RF Conducted Emissions 47 CFR 15.247(d) and RSS-247 (5.5) (10/31/2018)

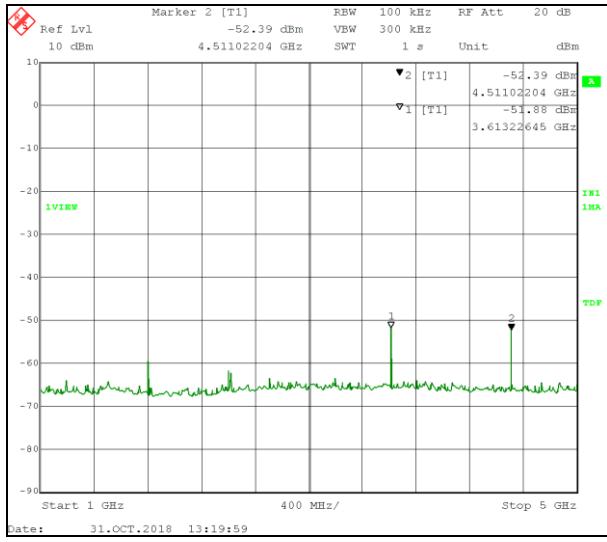
The antenna port of the Woodstream Model V400M LoRa Radio Control Unit was tested for compliance to the requirement that emissions, between 30 MHz and 10 GHz, outside the operating band, are 20 dB below the peak level of signals inside the operating band.



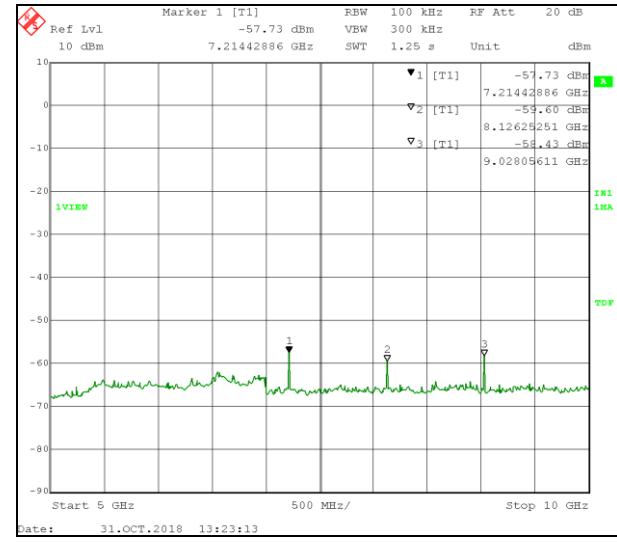
Channel 0, 902.3 MHz, 30 – 500 MHz



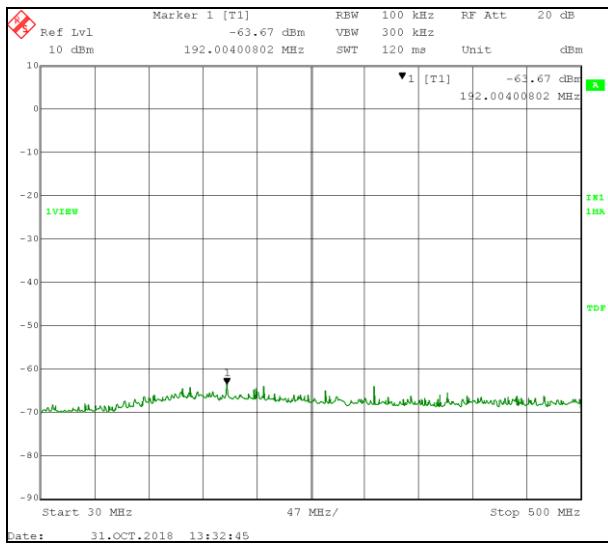
Channel 0, 902.3 MHz, 500 MHz – 1 GHz



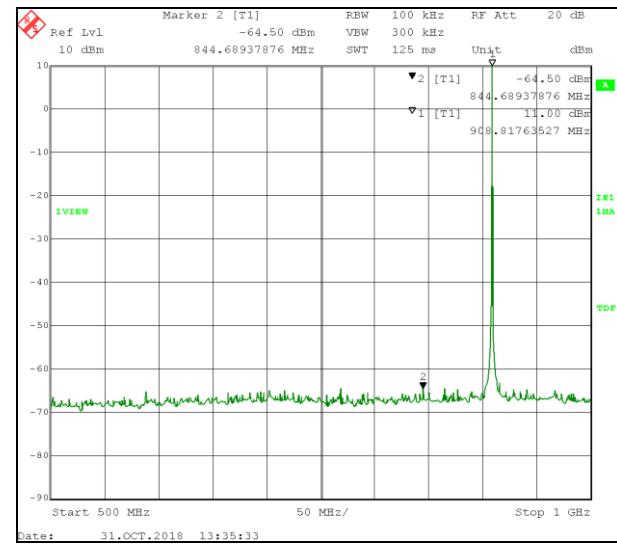
Channel 0, 902.3 MHz, 1 – 5 GHz



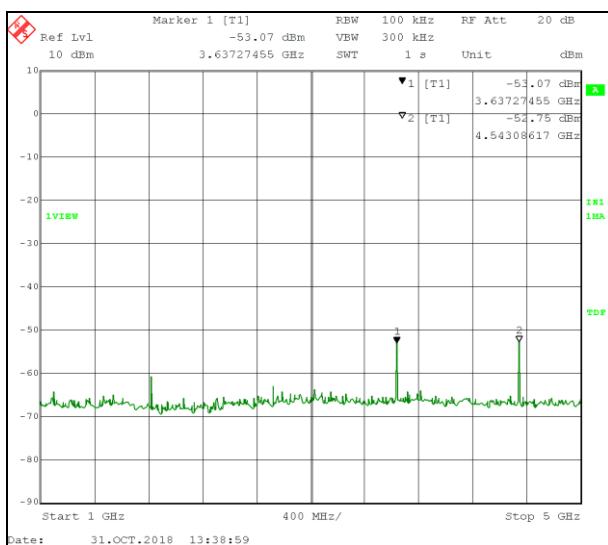
Channel 0, 902.3 MHz, 5 – 10 GHz



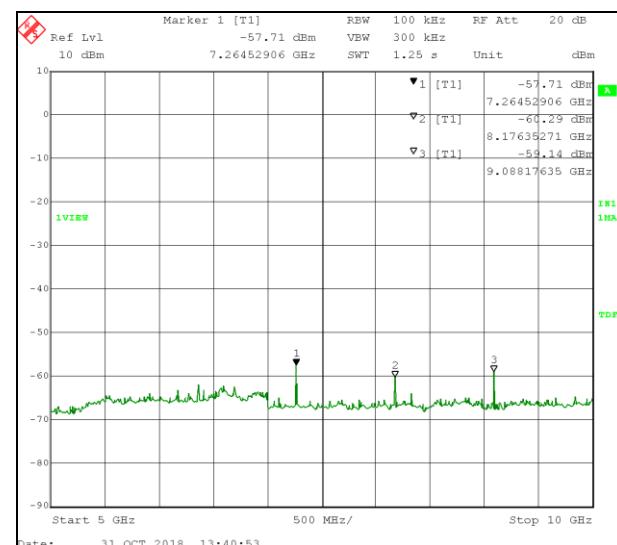
Channel 32, 908.7 MHz, 30 – 500 MHz



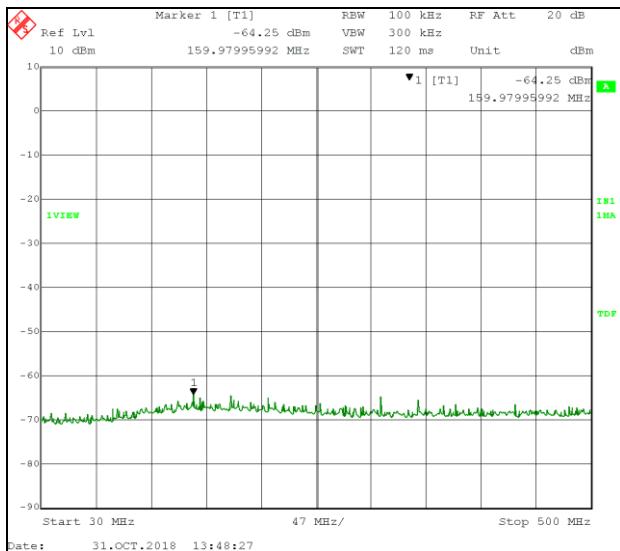
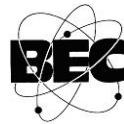
Channel 32, 908.7 MHz, 500 MHz – 1 GHz



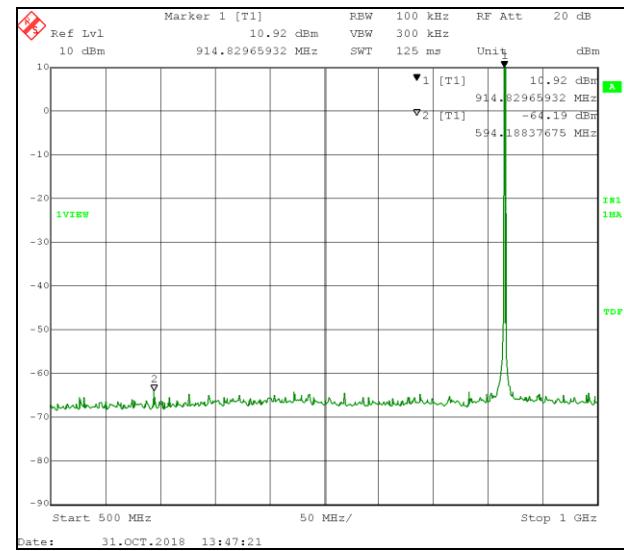
Channel 32, 908.7 MHz, 1 – 5 GHz



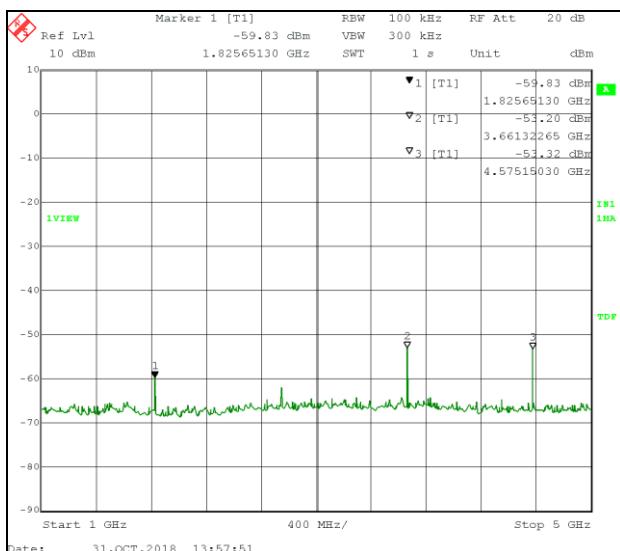
Channel 32, 908.7 MHz, 5 – 10 GHz



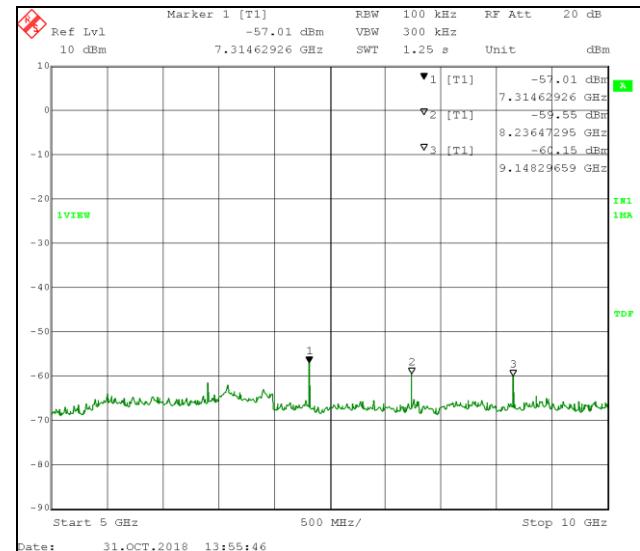
Channel 63, 914.9 MHz, 30 – 500 MHz



Channel 63, 914.9 MHz, 500 MHz – 1 GHz



Channel 63, 914.9 MHz, 1 – 5 GHz

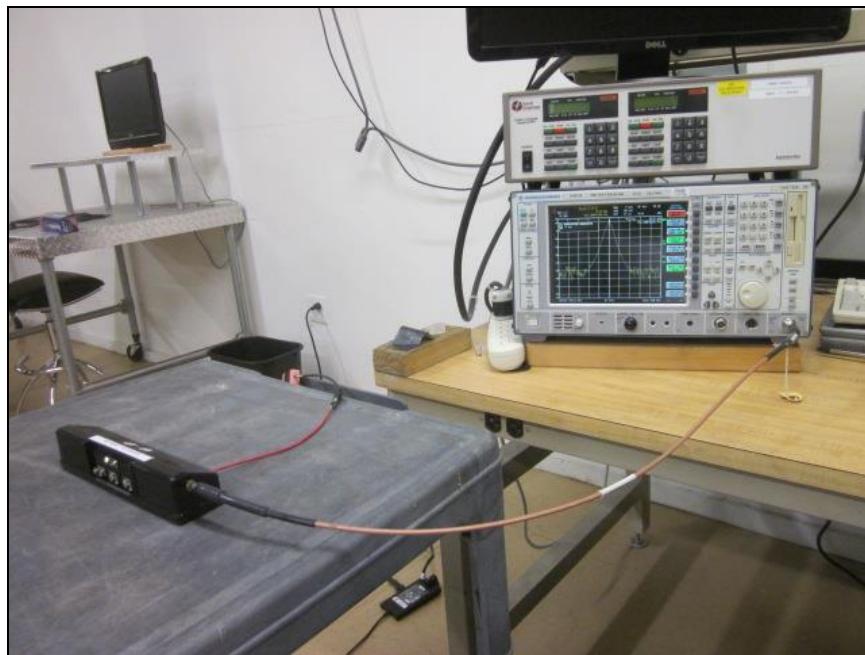


Channel 63, 914.9 MHz, 5 – 10 GHz

Test Results: Signals, measured from the Woodstream Model V400M LoRa Radio Control Unit antenna port, comply with the requirements of 47 CFR Part 15.247(d).



4.12 Antenna Conducted Measurements Test Setup Picture





Appendix A – Test Equipment

Equipment	Manufacturer	Model #	Serial #	BEC #	Calibration Date	Calibration Cycle	Calibration Due Date
EMI Receiver (20 Hz – 26.5 GHz)	Rohde & Schwarz	ESIB 26	836119/006	1010	07/01/16	3 Years	07/01/19
Antenna (30 MHz - 6 GHz)	Sunol Sciences	JB6	A022108	712	06/26/18	2 Years	06/26/20
9kHz-3GHz EMC Analyzer	Agilent	E7402A	US39440162	883	02/27/18	3 Years	02/27/21
Antenna (30 MHz - 6 GHz)	Sunol Sciences	JB6	A020714	882	05/16/18	2 Years	05/16/20
Amplifier (.09 – 1300 MHz)	Hewlett Packard	8447F	3313A06658	807	01/18/17	2 Years	01/18/19
EMC Analyzer (9 kHz - 26.5 GHz)	Hewlett Packard	8593EM	3710A00214	1026	03/02/17	2 Years	03/02/19
Amplifier System (0.5 – 50 GHz)	Hewlett Packard	83015A 83017A	3123A00360 & 3332A00219	1027	10/14/18	2 Years	10/14/20
Double Ridged Horn Antenna (1 - 18 GHz)	Eaton	3115	2113	836	12/16/15	3 Years	12/16/18
Shielded Room #1	ETS Lindgren	12-2/2-0	4078	859	05/17/18	2 Years	05/17/20
Intentional Radiator Testing High Frequency RF Test Cable	Workhorse	WHU18-3636-036	N/A	814	12/29/16	2 Years	12/29/18



OATS Site (30 MHz – 1 GHz)	BEC	N/A	N/A	705	05/16/18	1 Year	05/16/19
Temp/Humidity Meter	Control Company	4096	170522942	780	07/14/17	2 Years	07/14/19
Software (Tile Instrument Control System)	Quantum Change/EMC Systems	Version 3	N/A	N/A	No Cal. Required	No Cal. Required	No Cal. Required
Radiated Emissions Test Software	BEC	RADE	2.2	N/A	No Cal. Required	No Cal. Required	No Cal. Required