



BEC INCORPORATED

CERTIFICATION APPLICATION TEST REPORT

TEST STANDARDS:

**FCC Part 15 Subpart C, IC RSS-Gen, IC RSS-247
DTS Intentional Radiator**

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

**FCC ID: SNA-V400MR1
ISED ID: 9458A-V400M**

REPORT BEC-2065-02 REV1

TEST DATES: 02/04/2020 – 02/26/2020

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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Revision History

Revision #	Description of Changes	Date of Changes	Date Released
0	Test Report Initial Release	N/A	03/05/2020
1	Tested Frequencies are added to Section 1.1 of the test report	03/10/2020	03/10/2020



1.0 Administrative Information

1.1 Project Details

Project Number	BEC-2065	
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 Sample Numbers	2065-02	2065-01
LoRa Radio Control Unit Serial #s	None	
FCC ID	SNA-V400MR1	
ISED ID	9458A-V400M	
Radio Chip Manufacturer	Semtech Corporation	
Radio Chip Model Number	SX1272	
Frequency of Operation	902 – 915 MHz	
Frequencies Tested	Low (903 MHz), Middle (909.4 MHz), High (914.2 MHz)	
Antenna Gain	+ 3 dBi	
FCC Classification	Digital Transmission System (DTS)	
Date Samples Received	02/04/2020	
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 License-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 # 183621

1.4 Measurement Uncertainty

Measurement	Measurement Distance	Frequency Range	Measurement Limit	Expanded Uncertainty
Radiated Disturbance	3 Meter	30 MHz – 1 GHz	Class B	4.12
Conducted Disturbance AC Mains	N/A	150 kHz – 30 MHz	Class A or B	2.69

No adjustments to measured data presented in this report are required because all values of uncertainty are less than the CISPR 16-4-2:2018 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 and found to be compliant to the sections of the FCC Part 15 Subpart C standard listed below:

Report Section	FCC Part 15, Subpart C	RSS-Gen	RSS-247	Test Description	Result
N/A	15.207	7.2		Conducted Limits (AC Power)	N/A
4.1	15.203(b)	Annex A 10(g)		Antenna Requirement	PASS
4.2	15.204	8.3		External RF power amplifiers and antenna modifications	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)(2)		5.2 (a)	6 dB Occupied Bandwidth	PASS
4.6	15.247(b)(3)		5.4 (d)	Maximum Average, Peak Power Output and EIRP	PASS
4.7	15.247(d)		5.5	Antenna Port, Conducted Spurious Emissions	PASS
4.8	15.247(e)		5.2 (b)	Antenna Port, Power Spectral Density	PASS
4.9	15.247(d)		5.5	Band Edge Measurement	PASS

Interpretation of Test Results: The EUT was tested using LoRa modulation. 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 Incorporated and are available upon request.



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. Power for the V400M is provided by four, AA batteries.

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, DTS Operation within the band of 902 - 928 MHz.

2.4 Test Configuration

The Woodstream Model V400M LoRa Radio Control Unit Sample # 2065-02 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 # 2065-01 was tested without a trap enclosure for all antenna terminal measurements.

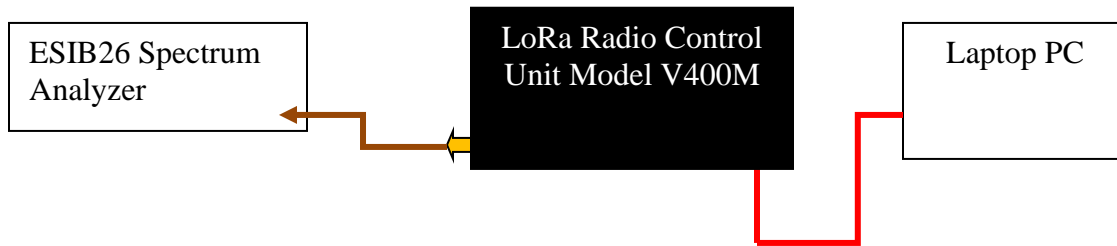
2.5 Test Configuration Rationale

The tested configurations are the two sizes of trap enclosures available by the manufacturer. The modified radio of the Woodstream Model V400M LoRa Radio Control Unit allows direct access to the output of the radio, without a transmission antenna.



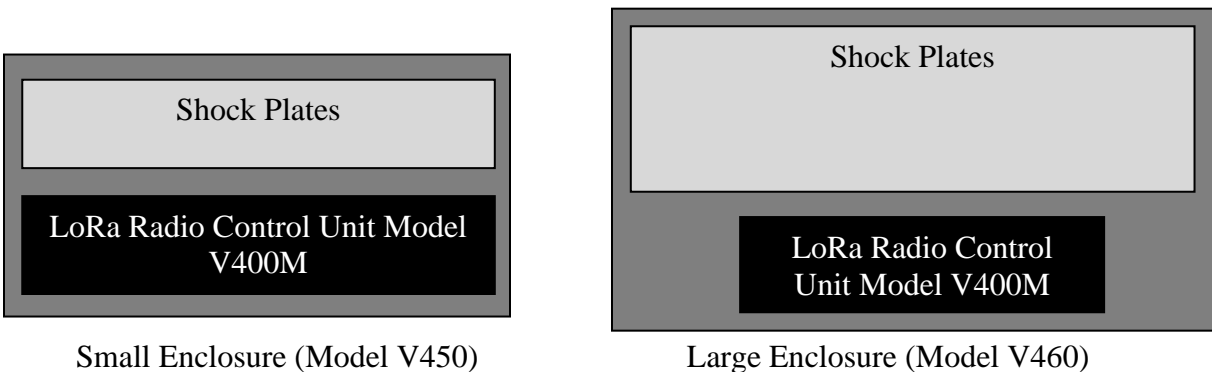
2.6 Test Configuration Diagram (Transmitter Conducted Measurements)

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	2065-02
Lora Radio Control Unit (modified with SMA)				2065-01

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
Mouse Trap Enclosure	Woodstream	V450	N/A
Rat Trap Enclosure	Woodstream	V460	N/A



2.9 Test Signals and Test Modulation

By design this product does not have an external Modulation input connector, therefore, normal operating modulation was used for all testing reported herein. The only test where modulation was not active was during testing of the Maximum Peak Power Output FCC Section 15.247(b) (3) (Section 4.6 of this report) to ensure that the un-modulated carrier was not higher than the modulated carrier.

The control unit in this product is a digital frequency transmitter. The EUT transmits to a discrete frequency on a specific channel. The Woodstream Model V400M LoRa Radio Control Unit has 8 Channels available. The 8 Channels and frequencies that can be transmitted by the EUT are as follows:

Channel	Frequency (MHz)		Channel	Frequency (MHz)
0	903.0		4	909.4
1	904.6		5	911.0
2	906.2		6	912.6
3	907.8		7	914.2

For the required testing, the EUT was configured to transmit at low Channel 0 (903 MHz), middle Channel 4 (909.4 MHz) and high Channel 7 (914.2 MHz). Spread factors values of 7 and 12 were examined. Evidence in the DTS Bandwidth Test (Section 4.5) and the Maximum Average Power Output Test (Section 4.6), demonstrates that a spread factor of 12 produces the greatest amplitude.

2.10 Grounding

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

2.11 EUT Modifications

With the exception for the attachment of an SMA connector directly to the antenna output on the main board of the Woodstream Model V400M LoRa Radio Control Unit (Sample # 2065-01), no modifications were made to the EUT.

2.12 EUT Pictures Woodstream Model V400M LoRa Radio Control Unit

See Appendix B Woodstream V400M External Photos



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

3.1.2 Industry Canada Requirements

RSS-Gen Issue 5 March 2019 Amendment 1: General Requirements for Compliance of Radio Apparatus

RSS-247 Issue 2 February 2017: Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices

3.1.3 Basic Test Methods and Test Procedures

558074 D01 15.247 Meas Guidance v05r02, Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating under Section 15.247.

ANSI C63.10-2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

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 quarter-wave, inverted F wire antenna. The antenna is mounted perpendicular to the PCB inside the enclosure. 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 amps/antenna modifications (47 CFR 15.204)(RSS-GEN 8.3)

There are no RF power amplifier kits available to be used with the Woodstream Model V400M LoRa Radio Control Unit. 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)(RSS-GEN 8.9)

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 Woodstream Model V400M LoRa Radio Control Unit was tested with each of the two enclosures; Model V450 and Model V460. The Woodstream Model V400M LoRa Radio Control Unit was tested at three frequencies: low (903 MHz), middle (909.4 MHz) and high (914.2 MHz). The modulation was LoRa.

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.

4.3.1 Restricted Bands Test Facility

OATS

The Open Area Test Site (OATS) is an all-weather facility with a wooden enclosure that contains a ground level 4-foot diameter turntable capable of rotating equipment 360 degrees. The enclosure is free of reflective metallic objects and extraneous electromagnetic signals. This non-metallic enclosure and the 3 and 10 meter test range existing outside the enclosure rest upon a protective insulating material, which in turn covers a flat, metal, continuous ground plane.

Instrumentation for remote control of the antenna mast, turntable, and other equipment are controlled by personnel indoors. 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 requirements of ANSI C63.4 and ANSI C63.10.



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 chamber complies with the requirements of ANSI C63.4 and ANSI C63.10.

4.3.2 Restricted Bands Radiated Emissions Test Procedure

Radiated Emissions 30 MHz – 40 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:

$$\text{Field Strength (dB}\mu\text{V/m)} = \text{Meter Reading (dB}\mu\text{V)} + \text{Antenna Factor (dB/m)} + \text{Cable Loss (dB)} \\ - \text{Amplifier Gain (dB)}$$

Measurements were made with the Woodstream Model V400M LoRa Radio Control Unit transmitting at low (Channel 0), middle (Channel 4) and high (Channel 7). LoRa modulation was applied with the spread factor = 12. The following tables are the highest emissions recorded and summarized. Each signal has the associated channel number and frequency when measured. The signals in the tables fall into the restricted bands described in 15.205.



4.3.3 Restricted Bands of Operation 30 MHz – 1000 MHz Test Results (02/11/2020 and 02/12/2020)

WOODSTREAM MODEL V400M IN THE SMALL ENCLOSURE (MODEL V450)

Freq	PkLevel	Quasi-Peak	Pol	Azimuth	Hght	C/F	FCC Part 15.205 Limit	Margin		Source
MHz	dBuV/m	dBuV/m	H or V	degrees	cm	dB	dBuV/m	dB	Result	Chan# / MHz
127.570	12.93	13.20	V	071	178	-6.74	43.52	-30.32	PASS	0/903
135.025	15.62	12.84	V	178	218	-7.08	43.52	-30.68	PASS	4/909.4
401.613	26.48	23.25	H	161	108	-7.70	46.02	-22.77	PASS	0/903
960.402	19.36	15.65	V	084	173	-3.46	53.98	-38.33	PASS	7/914.2
960.930	18.58	17.18	V	094	240	-3.44	53.98	-36.80	PASS	4/909.4
962.737	15.05	15.78	V	257	161	-3.39	53.98	-38.20	PASS	7/914.2
998.379	17.59	17.34	V	284	252	-3.05	53.98	-36.64	PASS	4/909.4
998.588	16.28	15.86	V	224	168	-3.04	53.98	-38.12	PASS	7/914.2

WOODSTREAM MODEL V400M IN THE LARGE ENCLOSURE (MODEL V460)

Freq	PkLevel	AVG Level	Pol	Azimuth	Hght	C/F	FCC Part 15.205 Limit	Margin		Source
MHz	dBuV/m	dBuV/m	H or V	degrees	cm	dB	dBuV/m	dB	Result	Chan# / MHz
118.849	14.64	11.59	V	179	135	-6.83	43.52	-31.93	PASS	7/914.2
128.267	13.38	13.14	V	137	220	-6.74	43.52	-30.38	PASS	0/903
133.910	13.32	13.15	V	317	158	-6.98	43.52	-30.37	PASS	4/909.4
324.648	28.20	26.70	H	023	104	-7.96	46.02	-19.32	PASS	4/909.4
324.862	25.63	25.03	H	050	100	-7.96	46.02	-20.99	PASS	7/914.2
325.589	25.02	19.93	H	052	099	-7.97	46.02	-26.09	PASS	0/903
328.051	27.00	25.66	H	055	111	-7.98	46.02	-20.36	PASS	4/909.4
328.300	26.92	23.95	H	030	104	-7.98	46.02	-22.07	PASS	7/914.2
331.490	25.71	25.05	H	035	119	-7.97	46.02	-20.97	PASS	4/909.4
975.268	19.19	17.15	V	204	116	-3.29	53.98	-36.83	PASS	0/903
987.271	17.75	17.28	V	028	189	-3.18	53.98	-36.70	PASS	4/909.4

Test Results: The Woodstream Model V400M LoRa Radio Control Unit, housed in either enclosure, complies with the requirements of 47 CFR Part 15.205 and RSS-Gen Section 8.10 for restricted bands of operation with a margin of 19.32 dB.



4.3.4 Restricted Bands of Operation 1 – 10 GHz Test Results (02/04/2020 - 02/06/2020)

WOODSTREAM MODEL V400M IN THE SMALL ENCLOSURE (MODEL V450)

Freq	Peak Level	AVG Level	Pol	Azimuth	Hght	C/F	FCC Part 15.205 Limit	Margin	Result	Source
GHz	dBuV/m	dBuV/m	H or V	degrees	cm	dB	dBuV/m	dB		Chan# / MHz
1.0266	30.64	20.77	H	246	192	-13.17	53.98	-33.21	PASS	7/914.2
1.0330	32.40	21.30	H	343	210	-13.13	53.98	-32.68	PASS	0/903
1.0361	29.96	21.31	V	257	188	-13.11	53.98	-32.67	PASS	7/914.2
1.0381	30.39	21.45	V	66	114	-13.09	53.98	-32.53	PASS	4/909.4
1.0410	30.43	20.93	V	037	101	-13.07	53.98	-33.05	PASS	0/903
1.0699	32.70	21.34	H	36	166	-12.88	53.98	-32.64	PASS	4/909.4
1.2202	30.70	20.93	V	110	101	-11.87	53.98	-33.05	PASS	7/914.2
1.2207	30.27	21.26	H	247	213	-11.86	53.98	-32.73	PASS	7/914.2
1.3636	29.70	20.78	V	311	178	-10.90	53.98	-33.20	PASS	0/903
1.3818	31.63	21.39	V	0	137	-10.78	53.98	-32.59	PASS	7/914.2
1.4057	32.13	21.81	H	195	181	-10.62	53.98	-32.17	PASS	7/914.2
2.7287	45.84	34.22	V	186	111	-3.25	53.98	-19.76	PASS	4/909.4
2.7432	37.43	37.13	V	170	101	-3.17	53.98	-16.85	PASS	7/914.2
3.4843	37.98	27.92	V	359	122	0.09	53.98	-26.06	PASS	0/903
4.5149	43.31	34.77	H	153	212	1.87	53.98	-19.21	PASS	0/903
4.5158	45.78	35.41	V	195	205	1.87	53.98	-18.57	PASS	0/903
4.5708	41.68	32.74	V	217	203	2.09	53.98	-21.24	PASS	7/914.2
8.1170	48.23	39.14	H	94	143	7.47	53.98	-14.85	PASS	7/914.2
8.1349	48.56	39.52	V	87	190	7.49	53.98	-14.46	PASS	4/909.4
8.1457	47.97	39.41	H	068	136	7.50	53.98	-14.57	PASS	0/903
8.2549	48.05	39.05	V	314	113	7.64	53.98	-14.93	PASS	0/903



WOODSTREAM MODEL V400M IN THE LARGE ENCLOSURE (MODEL V460)

Freq	PkLevel	AVG Level	Pol	Azimuth	Hght	C/F	FCC Part 15.205 Limit	Margin		Source
GHz	dBuV/m	dBuV/m	H or V	degrees	cm	dB	dBuV/m	dB	Result	Chan# / MHz
1.0307	31.18	21.48	V	273	118	-13.14	53.98	-32.50	PASS	7/914.2
1.0361	30.77	21.26	V	212	189	-13.11	53.98	-32.72	PASS	4/909.4
1.0475	30.65	22.59	H	194	129	-13.03	53.98	-31.39	PASS	0/903
1.0495	30.60	21.13	H	104	113	-13.02	53.98	-32.85	PASS	4/909.4
1.0602	32.22	21.91	V	318	139	-12.94	53.98	-32.07	PASS	0/903
1.0629	31.03	21.75	H	181	115	-12.93	53.98	-32.23	PASS	7/914.2
1.2324	30.63	20.75	V	359	166	-11.78	53.98	-33.23	PASS	0/903
1.3788	33.03	21.64	H	91	207	-10.80	53.98	-32.34	PASS	4/909.4
2.7094	46.11	39.62	V	149	101	-3.36	53.98	-14.36	PASS	0/903
2.7425	45.06	38.07	V	223	130	-3.18	53.98	-15.91	PASS	7/914.2
4.5462	39.09	36.14	V	239	205	1.99	53.98	-17.84	PASS	4/909.4
8.0754	48.19	38.76	H	170	125	7.41	53.98	-15.22	PASS	7/914.2
8.1175	48.07	39.10	H	195	169	7.47	53.98	-14.88	PASS	4/909.4
8.1328	49.23	38.89	H	314	131	7.48	53.98	-15.09	PASS	0/903
8.1399	49.33	39.05	V	202	133	7.49	53.98	-14.93	PASS	7/914.2
8.1409	48.34	39.33	V	269	201	7.49	53.98	-14.65	PASS	4/909.4

Test Results: The Woodstream Model V400M LoRa Radio Control Unit, housed in either enclosure, complies with the requirements of 47 CFR Part 15.205 and RSS-Gen Section 8.10 with a margin of 14.36 dB.



4.4. Spurious Radiated Emissions 30 MHz to 10 GHz (47 CFR 15.209)(RSS-GEN 8.10)

The following tables shows the highest amplitude average detected field strengths as recorded from the EUT. These measurements were performed over the frequency range of 30 MHz to 1000 MHz at a distance of 3 meters to satisfy FCC Section 15.209 requirements. Spurious emissions from the EUT were measured at low, middle and high transmit frequencies. LoRa modulation, with a spread factor of 12 was applied. The measurements below were made using the same facility and procedure as the Restricted Band measurements.

4.4.1 Spurious Radiated Emissions 30 MHz to 1 GHz Test Results (02/11/2020 and 02/12/2020)

WOODSTREAM MODEL V400M IN THE SMALL ENCLOSURE (MODEL V450)

Freq	PkLevel	Quasi-Peak	Pol	Azimuth	Hght	C/F	FCC Part 15.209 Limit	Margin		Source
MHz	dBuV/m	dBuV/m	H or V	degrees	cm	dB	dBuV/m	dB	Result	Chan# / MHz
30.922	19.68	19.15	V	338	152	-0.94	40.00	-20.85	PASS	4/909.4
30.951	21.39	19.15	H	042	255	-0.95	40.00	-20.85	PASS	0/903
31.501	20.02	18.72	V	298	185	-1.42	40.00	-21.28	PASS	0/903
370.858	31.37	29.53	H	189	103	-7.80	46.02	-16.49	PASS	0/903
373.554	28.43	25.58	H	196	101	-7.76	46.02	-20.44	PASS	4/909.4
374.221	32.16	30.93	H	206	099	-7.75	46.02	-15.09	PASS	0/903
377.071	26.77	25.93	H	207	101	-7.74	46.02	-20.09	PASS	4/909.4
377.721	32.78	30.55	H	183	101	-7.74	46.02	-15.47	PASS	0/903
380.206	25.09	24.83	H	204	235	-7.74	46.02	-21.19	PASS	4/909.4
381.198	32.77	31.58	H	201	235	-7.74	46.02	-14.44	PASS	0/903
384.593	31.35	30.39	H	185	235	-7.72	46.02	-15.63	PASS	0/903
387.778	29.29	29.32	H	182	104	-7.73	46.02	-16.70	PASS	0/903
391.183	30.43	29.25	H	183	099	-7.73	46.02	-16.77	PASS	0/903
395.167	29.18	26.66	H	190	104	-7.74	46.02	-19.36	PASS	0/903
397.744	29.27	27.99	H	198	103	-7.71	46.02	-18.03	PASS	0/903
482.611	29.56	27.36	H	189	207	-7.73	46.02	-18.66	PASS	4/909.4
484.149	29.43	27.79	H	183	207	-7.71	46.02	-18.23	PASS	0/903
486.371	28.04	25.86	H	204	207	-7.67	46.02	-20.16	PASS	7/914.2
486.419	29.50	26.85	H	202	208	-7.67	46.02	-19.17	PASS	4/909.4
503.549	26.35	24.25	H	180	219	-7.15	46.02	-21.77	PASS	7/914.2



WOODSTREAM MODEL V400M IN THE LARGE ENCLOSURE (MODEL V460)

Freq	PkLevel	AVG Level	Pol	Azimuth	Hght	C/F	FCC Part 15.209 Limit	Margin		Source
MHz	dBuV/m	dBuV/m	H or V	degrees	cm	dB	dBuV/m	dB	Result	Chan# / MHz
30.180	20.67	19.56	H	285	255	-0.58	40.00	-20.44	PASS	4/909.4
30.327	18.70	19.45	V	151	219	-0.65	40.00	-20.55	PASS	0/903
30.337	19.12	17.91	H	143	103	-0.65	40.00	-22.09	PASS	7/914.2
30.759	18.49	17.79	V	126	210	-0.86	40.00	-22.21	PASS	7/914.2
30.797	19.37	19.28	V	229	179	-0.88	40.00	-20.72	PASS	4/909.4
31.201	18.93	18.90	H	111	208	-1.16	40.00	-21.10	PASS	0/903
321.550	27.10	25.92	H	039	105	-7.94	46.02	-20.10	PASS	4/909.4
321.800	26.22	23.85	H	031	099	-7.94	46.02	-22.17	PASS	7/914.2
459.735	31.58	30.87	H	359	188	-8.06	46.02	-15.15	PASS	0/903
459.846	28.04	27.21	H	009	197	-8.06	46.02	-18.81	PASS	7/914.2
463.430	33.75	31.23	H	011	193	-8.06	46.02	-14.79	PASS	4/909.4
463.467	31.38	30.96	H	007	188	-8.06	46.02	-15.06	PASS	4/909.4
463.507	32.84	31.30	H	012	191	-8.06	46.02	-14.72	PASS	0/903
465.711	29.61	28.15	H	022	197	-8.05	46.02	-17.87	PASS	7/914.2
466.872	33.46	30.61	H	001	203	-8.03	46.02	-15.41	PASS	0/903
469.542	30.31	27.13	H	001	203	-7.97	46.02	-18.89	PASS	7/914.2
473.538	30.03	28.99	H	219	247	-7.90	46.02	-17.03	PASS	0/903
477.244	29.95	28.63	H	217	188	-7.83	46.02	-17.39	PASS	0/903
477.738	28.80	27.17	H	003	193	-7.82	46.02	-18.85	PASS	4/909.4
480.407	31.28	29.32	H	196	198	-7.76	46.02	-16.70	PASS	0/903
481.433	26.37	22.64	H	007	208	-7.75	46.02	-23.38	PASS	4/909.4
484.033	26.58	23.40	H	199	191	-7.71	46.02	-22.62	PASS	0/903

Test Results: Spurious radiated emissions, recorded at a distance of 3 meters from the Woodstream Model V400M LoRa Radio Control Unit, in either enclosure, are below the 3 meter limit specified by FCC Section 15.209 and RSS-Gen Section 8.10 requirements by a margin of at least 14.72 dB.



4.4.2 Spurious Radiated Emissions 1 to 10 GHz Test Results (02/04/2020 - 02/06/2020)

WOODSTREAM MODEL V400M IN THE SMALL ENCLOSURE (MODEL V450)

Freq	PkLevel	AVG Level	Pol	Azimuth	Hght	C/F	FCC Part 15.209 Limit	Margin	Result	Source
GHz	dBuV/m	dBuV/m	H or V	degrees	cm	dB	dBuV/m	dB		Chan# / MHz
1.8025	33.44	23.05	H	50	186	-7.99	53.98	-30.93	PASS	7/914.2
1.8062	40.03	37.74	V	250	117	-7.97	53.98	-16.24	PASS	0/903
1.8063	36.73	34.03	H	117	170	-7.96	53.98	-19.96	PASS	0/903
1.8188	39.82	33.76	H	118	100	-7.88	53.98	-20.22	PASS	4/909.4
1.8188	43.26	40.68	V	93	173	-7.88	53.98	-13.30	PASS	4/909.4
1.8281	40.76	38.97	V	113	194	-7.82	53.98	-15.01	PASS	7/914.2
1.8289	35.96	30.54	H	111	205	-7.82	53.98	-23.44	PASS	7/914.2
1.9602	33.15	23.29	H	293	178	-6.95	53.98	-30.70	PASS	7/914.2
2.4002	36.31	25.69	H	69	153	-4.95	53.98	-28.29	PASS	4/909.4
2.4022	34.11	24.96	V	312	179	-4.94	53.98	-29.02	PASS	7/914.2
2.4080	35.60	25.11	H	87	168	-4.92	53.98	-28.87	PASS	7/914.2
2.4119	34.64	25.40	V	324	101	-4.90	53.98	-28.59	PASS	4/909.4
2.4155	34.37	26.17	H	271	167	-4.89	53.98	-27.81	PASS	0/903
2.7088	45.11	38.08	V	189	107	-3.36	53.98	-15.90	PASS	0/903
3.2115	37.70	27.90	V	65	115	-0.95	53.98	-26.08	PASS	7/914.2
3.5232	37.76	28.62	V	8	110	0.22	53.98	-25.36	PASS	7/914.2
3.5373	38.42	28.95	H	1	101	0.27	53.98	-25.03	PASS	4/909.4
6.5983	44.09	34.71	H	324	133	5.01	53.98	-19.27	PASS	7/914.2
7.9219	48.45	38.22	V	237	129	7.27	53.98	-15.76	PASS	7/914.2
9.2060	48.40	39.93	H	25	170	8.83	53.98	-14.05	PASS	4/909.4
9.9180	48.25	39.04	H	246	118	8.75	53.98	-14.94	PASS	7/914.2



WOODSTREAM MODEL V400M IN THE LARGE ENCLOSURE (MODEL V460)

Freq	PkLevel	AVG Level	Pol	Azimuth	Hght	C/F	FCC Part 15.209 Limit	Margin	Result	Source
GHz	dBuV/m	dBuV/m	H or V	degrees	cm	dB	dBuV/m	dB		Chan# / MHz
1.8057	37.17	31.91	H	108	137	-7.97	53.98	-22.07	PASS	0/903
1.8059	40.80	34.06	V	250	103	-7.97	53.98	-19.92	PASS	0/903
1.8190	43.74	38.44	V	250	147	-7.88	53.98	-15.54	PASS	4/909.4
1.8228	32.49	22.77	H	155	129	-7.86	53.98	-31.21	PASS	4/909.4
1.8286	36.46	32.72	H	313	115	-7.82	53.98	-21.26	PASS	7/914.2
1.8288	36.95	29.45	V	235	125	-7.82	53.98	-24.53	PASS	7/914.2
2.4076	34.11	25.80	V	145	168	-4.92	53.98	-28.18	PASS	7/914.2
2.4104	36.95	25.78	H	354	179	-4.91	53.98	-28.20	PASS	4/909.4
2.4123	35.82	25.42	H	327	170	-4.90	53.98	-28.56	PASS	7/914.2
2.4188	34.17	25.27	H	25	186	-4.87	53.98	-28.71	PASS	7/914.2
2.4193	35.88	25.54	H	1	145	-4.87	53.98	-28.44	PASS	0/903
2.7283	42.92	38.13	V	209	188	-3.26	53.98	-15.85	PASS	4/909.4
3.2483	38.42	28.63	H	331	193	-0.81	53.98	-25.35	PASS	0/903
9.9233	49.10	39.09	V	206	162	8.75	53.98	-14.89	PASS	0/903

Test Results: Spurious radiated emissions, recorded at a distance of 3 meters from the Woodstream Model V400M LoRa Radio Control Unit, in either enclosure, are below the 3 meter limit specified by FCC Section 15.209 and RSS-Gen Section 8.10 requirements by a margin of at least 13.30 dB.



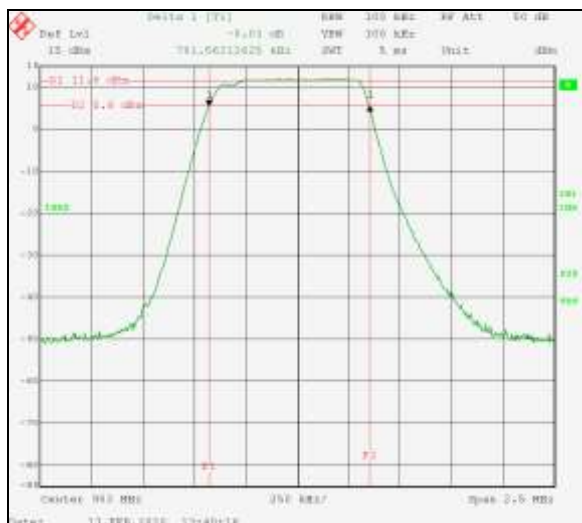
4.5 DTS 6 dB Occupied Bandwidth (FCC Section 15.247(a)(2) RSS-247 5.2(a))

4.5.1 6 dB Occupied Bandwidth – Test Procedure

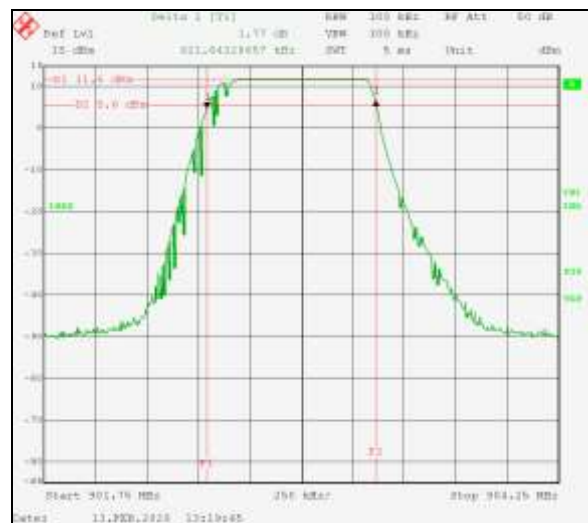
The minimum DTS (6 dB) bandwidth, specified in FCC Section 15.247(a) (2) was measured using a Spectrum Analyzer with 100 kHz resolution bandwidth and 300 kHz video bandwidth. Transmission frequencies at low (Channel 0), middle (Channel 4) and high (Channel 7) were measured with LoRa modulation and minimum spread factor of 7 and maximum spread factor of 12.

4.5.2 DTS (6 dB) Occupied Bandwidth Test Results (02/13/2020)

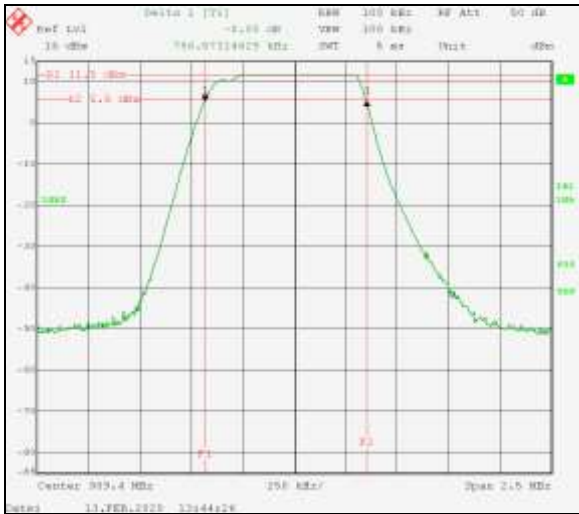
Channel	Spread Factor	Frequency	Measured 6 dB Bandwidth
		MHz	kHz
0	7	903.00	781.56
4		909.40	786.57
7		914.20	781.56
0	12	903.00	821.64
4		909.40	746.49
7		914.20	741.48



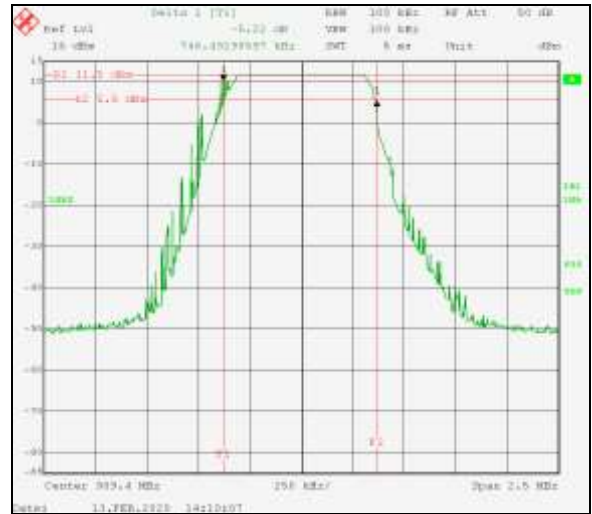
Channel 0: 903.00 MHz SF=7



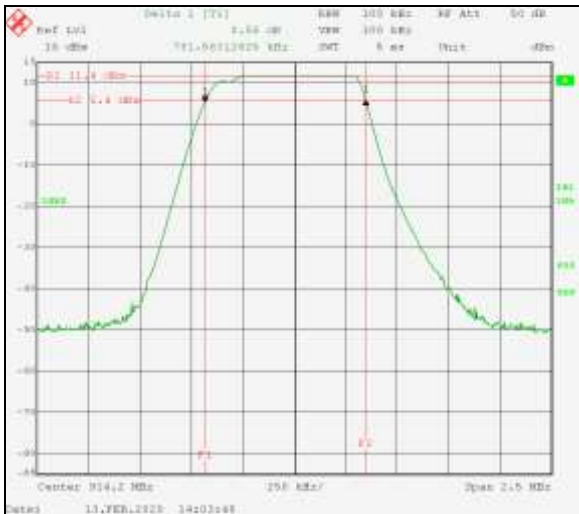
Channel 0: 903.00 MHz SF=12



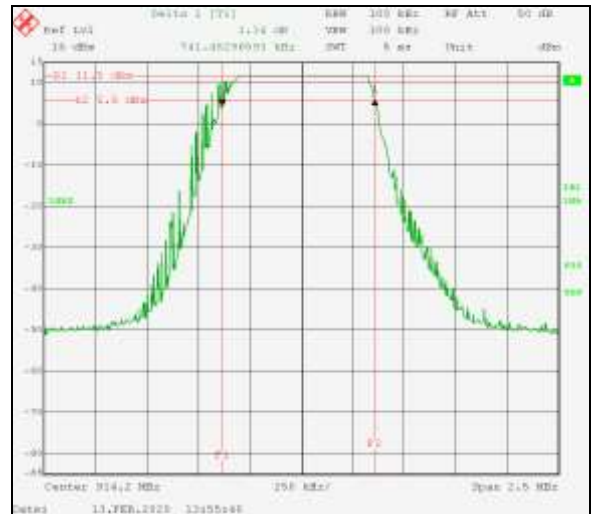
Channel 4: 909.40 MHz SF=7



Channel 4: 909.40 MHz SF=12



Channel 7: 914.20 MHz SF=7



Channel 7: 914.20 MHz SF=12

Test Results: The DTS, 6 dB, Occupied Bandwidth measurements for the Woodstream Model V400M LoRa Radio Control Unit were measured and used to select bandwidths and frequency spans for other radio measurements.



4.6 Maximum Conducted Output Power and EIRP (FCC Part 15.247(b)(3), RSS-247 Section 5.4(d))

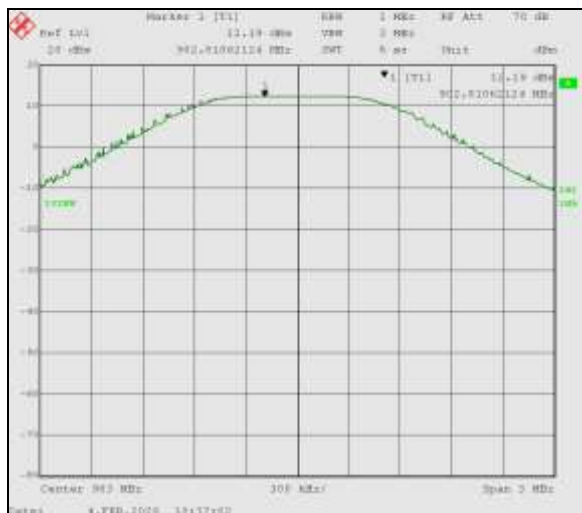
4.6.1 Maximum Conducted Output Power Test Procedure

A conducted power measurement of the output frequency was measured according to 558074 D01 15.247 Meas Guidance v05r02 using a peak detector. Spectrum Analyzer Resolution Bandwidth and Frequency Span were based upon the Operating Bandwidth (OBW) measured in the previous section. Transmission frequencies at low (Channel 0), middle (Channel 4) and high (Channel 7) were measured with LoRa modulation and minimum spread factor of 7 and maximum spread factor of 12.

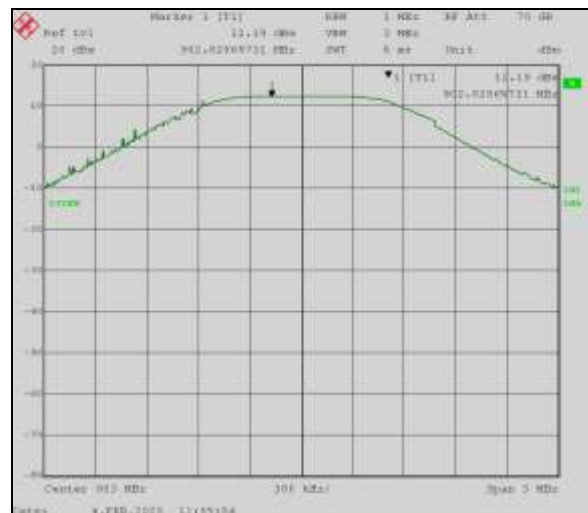
4.6.2 Maximum Conducted Output Power Test Results (02/04/2020)

Channel	Modulation	Frequency (MHz)	Measured Level	Cable #	814 Loss	Total		Limit		Margin	
						dBm	Watts	dBm	Watts	dBm	Watts
0	LoRa BW 500 SF = 7	903.0	12.19	0.33	12.52	0.018	30.00	1.000	-17.48	-0.982	
4		909.4	12.13	0.34	12.47	0.018	30.00	1.000	-17.53	-0.982	
7		914.2	12.12	0.35	12.47	0.018	30.00	1.000	-17.53	-0.982	
0	LoRa BW 500 SF = 12	903.0	12.19	0.33	12.52	0.018	30.00	1.000	-17.48	-0.982	
4		909.4	12.25	0.34	12.59	0.018	30.00	1.000	-17.41	-0.982	
7		914.2	12.11	0.35	12.46	0.018	30.00	1.000	-17.54	-0.982	

Below are the spectrum analyzer screens of the peak output power measurements.



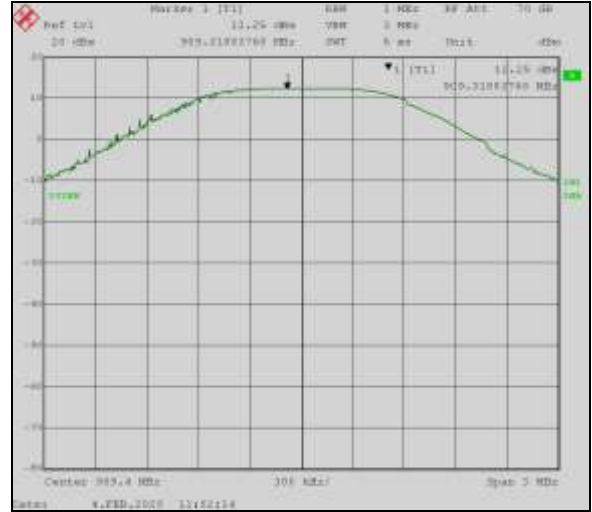
Channel 0, Spread Factor = 7



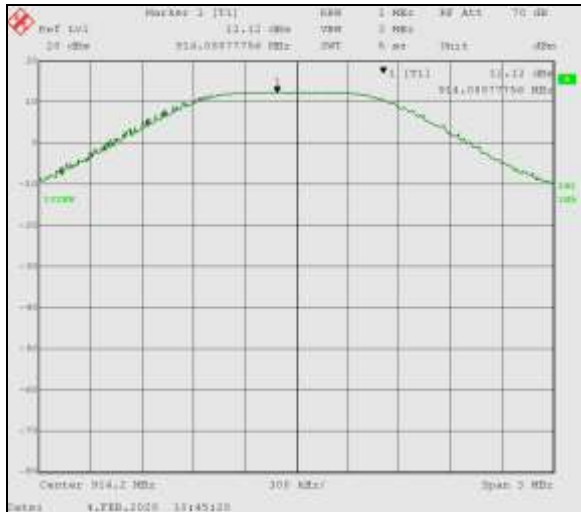
Channel 0, Spread Factor = 12



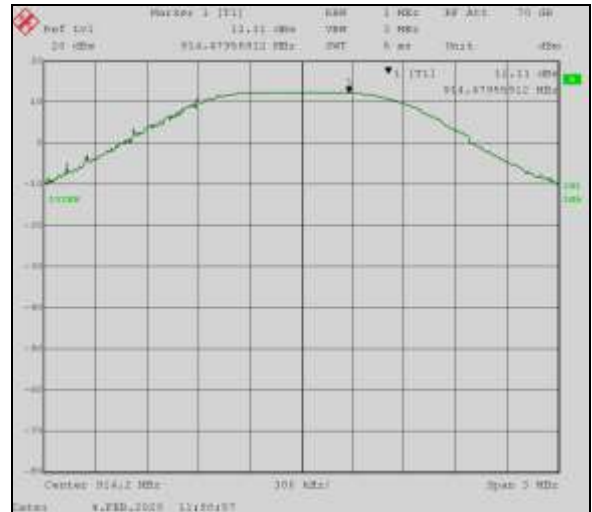
Channel 4, Spread Factor = 7



Channel 4, Spread Factor = 12



Channel 7, Spread Factor = 7



Channel 7, Spread Factor = 12

Test Results: The Maximum Conducted Output Power peak measurements for the Woodstream Model V400M LoRa Radio Control Unit are compliant with the limits specified in FCC Section 15.247(b)(3). The Spread Factor of 12 produces the greatest output level.



4.6.3 EIRP Calculation RSS-247 (02/04/2020)

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 peak transmitter output produces the following values of EIRP.

Channel	Modulation	Frequency (MHz)			Antenna Gain		EIRP			
			dBm	Watts	Isotropic	Numeric	Total		Limit	Margin
							dBm	Watts	Watts	Watts
0	None	903.0	12.52	0.018	3.00	1.995	15.52	0.036	4.00	-3.964
4		909.4	12.45	0.018	3.00	1.995	15.45	0.035	4.00	-3.965
7		914.2	12.47	0.018	3.00	1.995	15.47	0.035	4.00	-3.965

Channel	Modulation	Frequency (MHz)			Antenna Gain		EIRP			
			dBm	Watts	Isotropic	Numeric	Total		Limit	Margin
							dBm	Watts	Watts	Watts
0	LoRa SF = 7	903.0	12.52	0.018	3.00	1.995	15.52	0.036	4.00	-3.964
4		909.4	12.47	0.018	3.00	1.995	15.47	0.035	4.00	-3.965
7		914.2	12.47	0.018	3.00	1.995	15.47	0.035	4.00	-3.965

Channel	Modulation	Frequency (MHz)			Antenna Gain		EIRP			
			dBm	Watts	Isotropic	Numeric	Total		Limit	Margin
							dBm	Watts	Watts	Watts
0	LoRa SF = 12	903.0	12.52	0.018	3.00	1.995	15.52	0.036	4.00	-3.964
4		909.4	12.59	0.018	3.00	1.995	15.59	0.036	4.00	-3.964
7		914.2	12.46	0.018	3.00	1.995	15.46	0.035	4.00	-3.965

The results in the above table show compliance to the ISED requirements for EIRP limits per RSS-247.

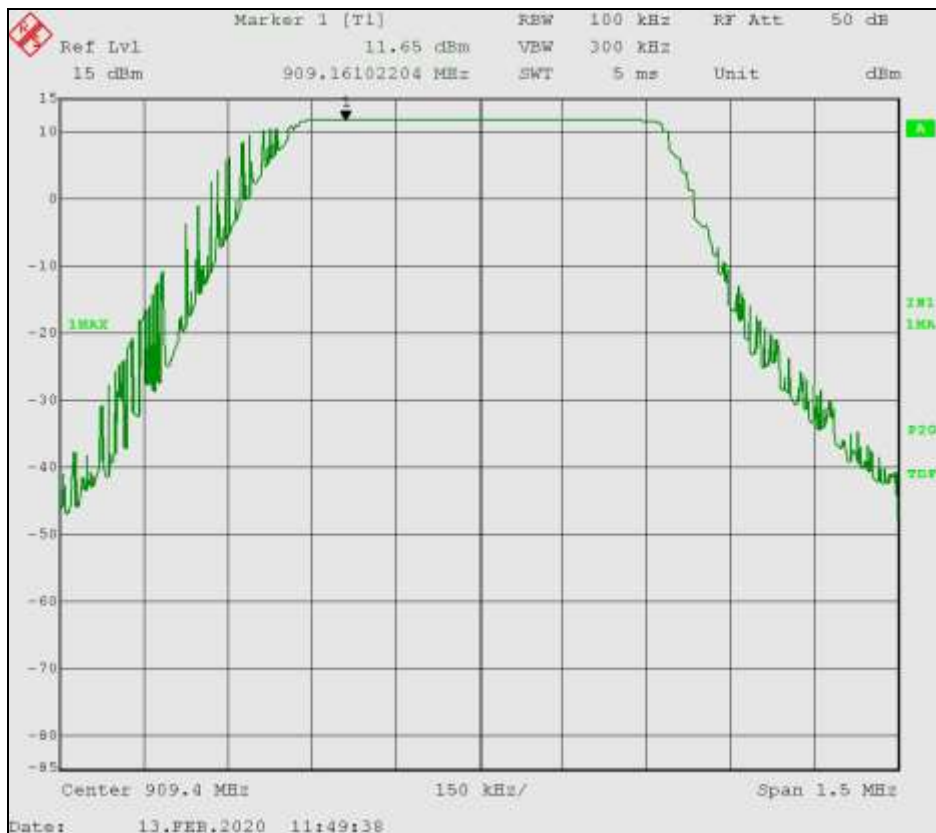


4.7 Antenna Conducted Spurious Emissions (FCC Section 15.247(d), RSS-247 Sec.5)

4.7.1 Antenna Conducted Spurious Emissions Test Procedure

A conducted power measurement of the output frequency was measured for to low (Channel 0), middle (Channel 4) and high (Channel 7) channel frequencies with Spread Factors of 7 and 12. The signal output was maximized with modulation. Three Frequency Sections were examined in the range of 30 to 1000 MHz and 1 to 10 GHz. 558074 D01 15.247 Meas Guidance v05r02 advises to use the Power Spectral Density results to determine which carrier frequency to use to determine the Reference Level for the Spurious conducted emissions test. The middle frequency of 909.4 MHz showed the highest PSD level by 0.02 dB. Therefore, 909.4 is the reference level shown below.

4.7.2 Antenna Conducted Spurious Emissions 20 dB Reference. (02/13/2020)

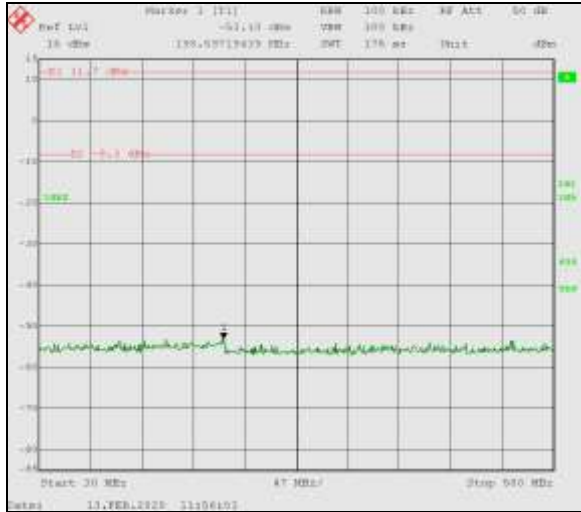


The peak level of 11.65 dBm is the maximum peak output of the Woodstream Model V400M LoRa Radio Control Unit. The conducted spurious emissions from the antenna port must be 20 dB down from this peak. The resultant limit is therefore -8.3 dBm and is displayed on the plots below.

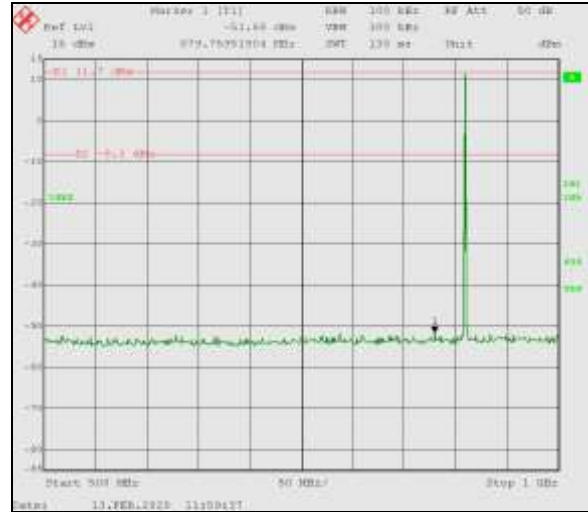


4.7.3 Antenna Conducted Spurious Emissions Test Results (02/13/2020)

Frequency Range: 30 MHz to 1000 MHz

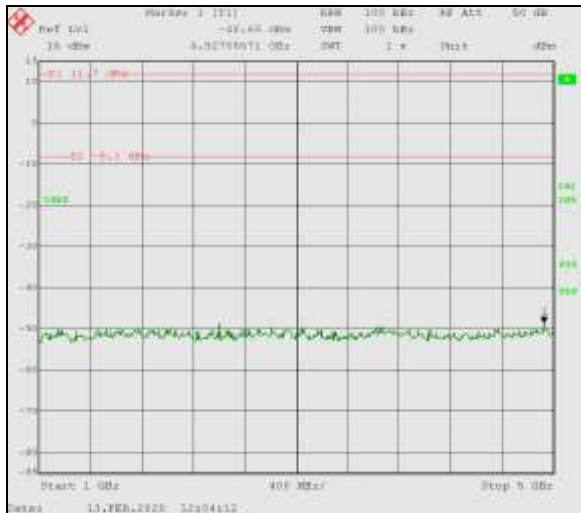


Channel 4, 909.4 MHz, 30 – 500 MHz

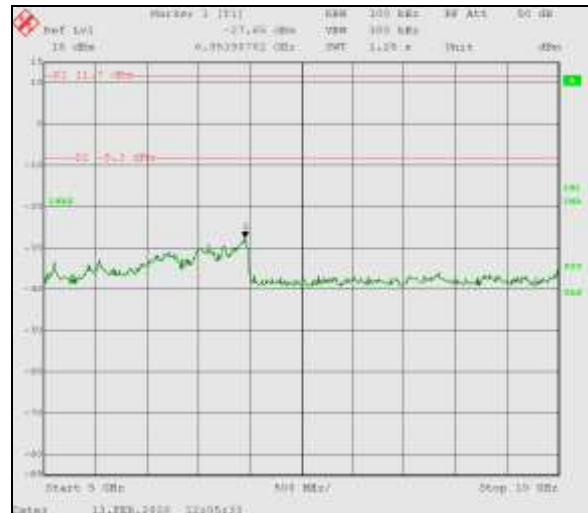


Channel 4, 909.4 MHz, 500 – 1000 MHz

Frequency Range: 1 to 10 GHz



Channel 4, 909.4 MHz, 1 – 5 GHz



Channel 4, 909.4 MHz, 5 – 10 GHz

Test Results: The Antenna Conducted Spurious Emissions of the Woodstream Model V400M LoRa Radio Control Unit are below the carrier -20 dB peak limit and therefore compliant with the limits specified in FCC Section 15.247(d).



4.8 Power Spectral Density (FCC Section 15.247(e), RSS-247 Section 5.2(b))

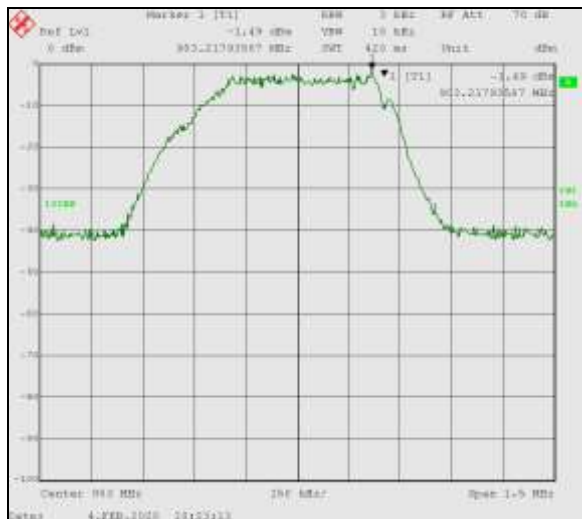
4.8.1 Power Spectral Density Test Procedure

A conducted power measurement of the output frequency was measured using a peak detector for the Woodstream V400M for each of the low (Channel 0), middle (Channel 4) and high (Channel 7) channel frequencies. The signal output was maximized with LoRa modulation using a Spread Factor of 7 and Spread Factor of 12.

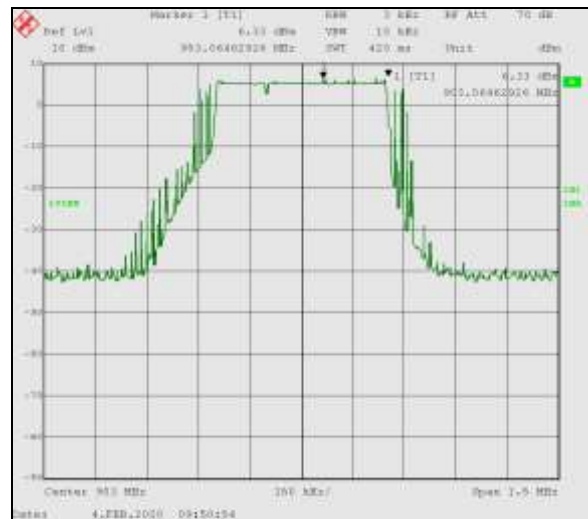
4.8.2 Power Spectral Density Test Results (02/04/2020)

Modulation and Spread Factor	Frequency (MHz)	Measured Level (dBm)	Cable # 814 Loss (dB)	Total	Limit	Margin
				dBm	dBm	dBm
LoRa Modulation with Spread Factor of 7	903.0	-1.49	0.33	-1.16	8.00	-9.16
	909.4	-2.42	0.34	-2.08	8.00	-10.08
	914.2	-2.21	0.35	-1.86	8.00	-9.86

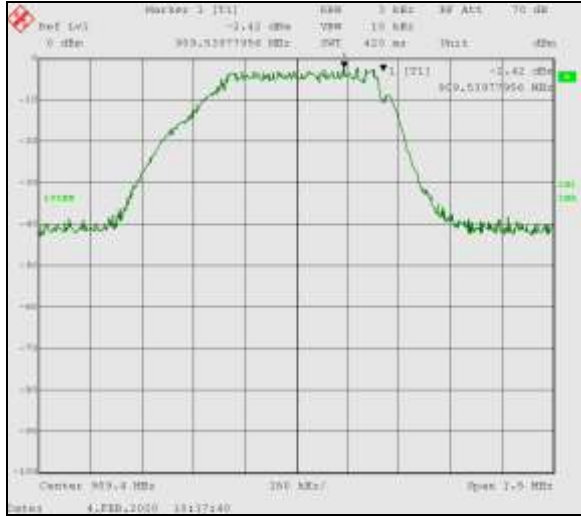
Modulation and Spread Factor	Frequency (MHz)	Measured Level (dBm)	Cable # 814 Loss (dB)	Total	Limit	Margin
				dBm	dBm	dBm
LoRa Modulation with Spread Factor of 12	903.0	6.33	0.33	6.66	8.00	-1.34
	909.4	6.28	0.34	6.62	8.00	-1.38
	914.2	6.03	0.35	6.38	8.00	-1.62



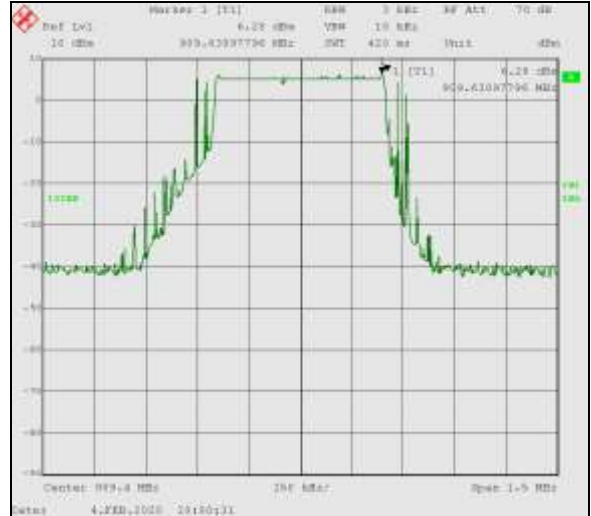
Channel 0, Spread Factor = 7



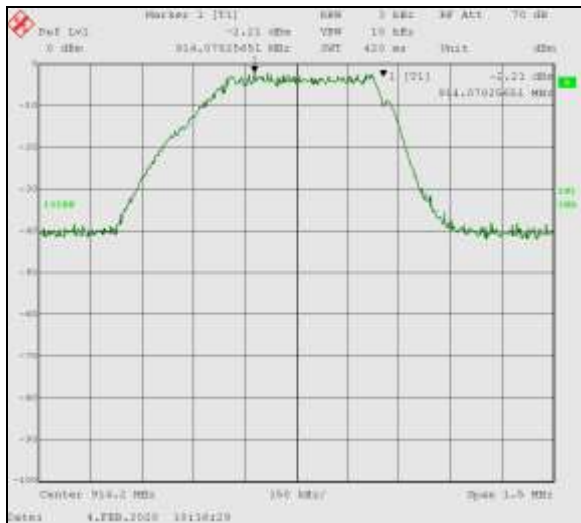
Channel 0, Spread Factor = 12



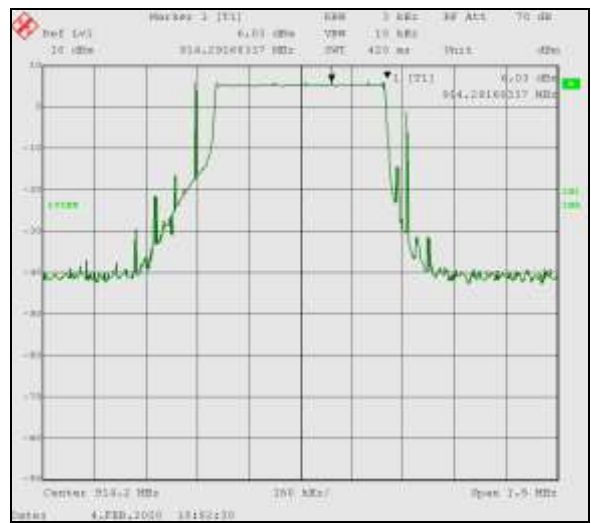
Channel 4, Spread Factor = 7



Channel 4, Spread Factor = 12



Channel 7, Spread Factor = 12



Channel 7, Spread Factor = 7

Test Results: The Power Spectral Density measurements of the Woodstream Model V400M LoRa Radio Control Unit are compliant with the limits specified in FCC Section 15.247(e) and RSS-247.



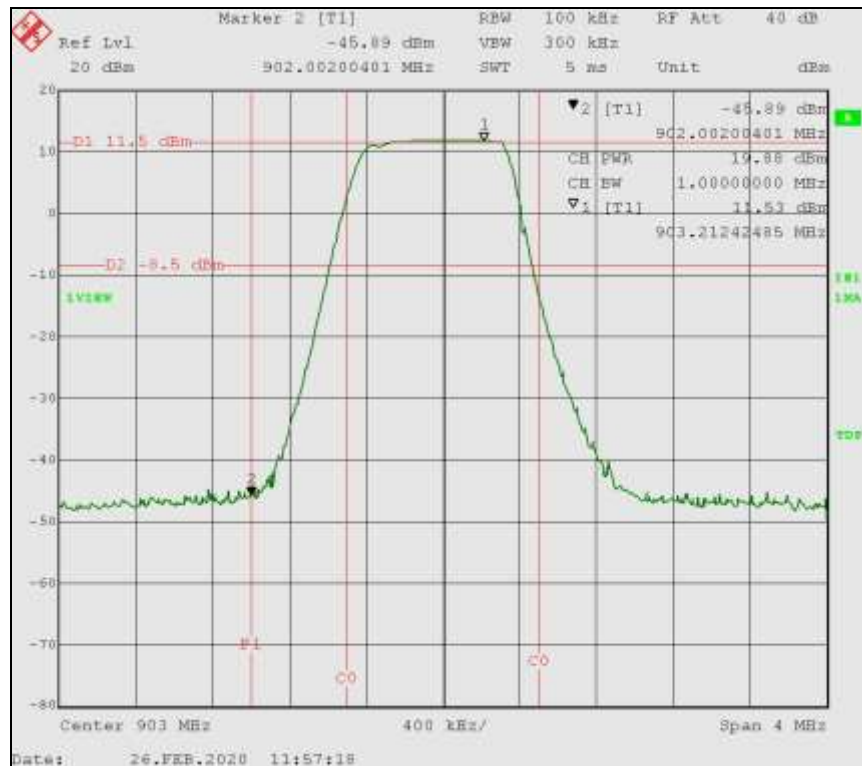
4.9 Band Edge Measurement (FCC Part 15.247(d), RSS-247 5.5)

4.9.1 Band Edge Measurement Test Procedure

Band edge measurements were recorded on the EUT while operating with a modulated carrier at 903 MHz (Channel 0). This frequency is the emission that falls within 2 MHz of the lower band edge of the operating bandwidth of the device. The Band Edge measurements were made using the Integration Method of Section 11.13.3.2 of ANSI C63.10. The Spectrum Analyzer Screens below show emissions between the modulated carrier, at low and high frequencies and the lower and upper band edges.

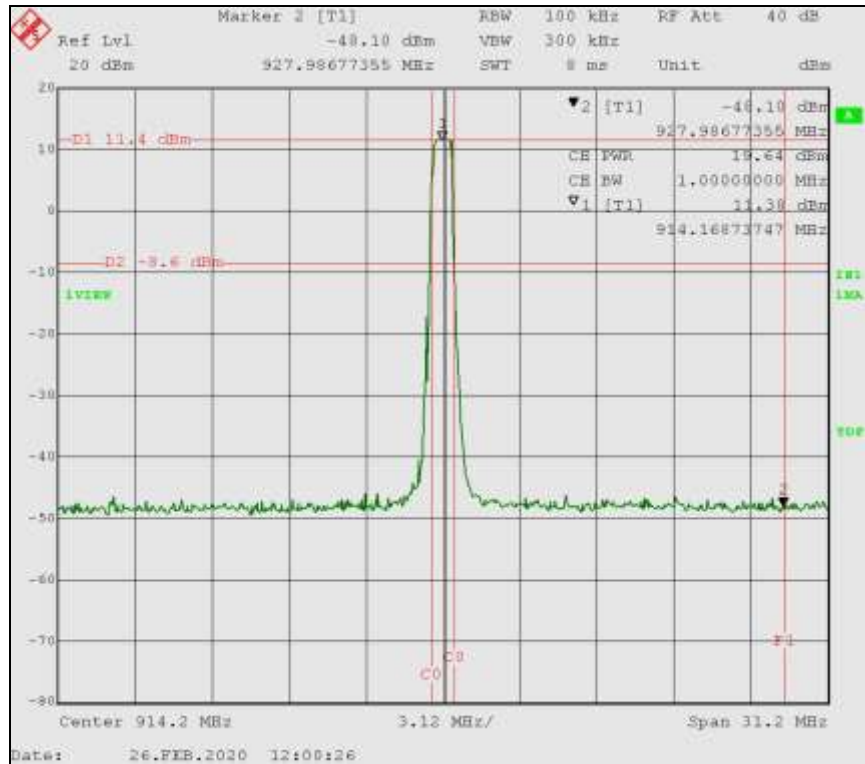
4.9.2 Band Edge Measurement Test Results (02/26/2020)

Low Channel 0, 903 MHz, 500 kHz BW, Spread Factor = 7

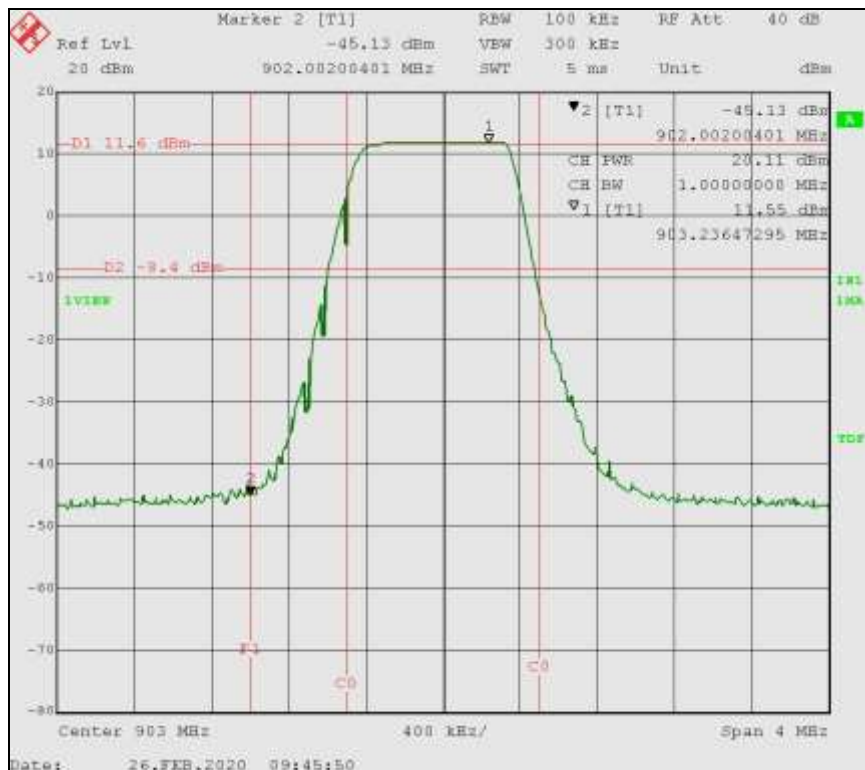




High Channel 63, 914.2 MHz, 500 kHz BW, Spread Factor = 7

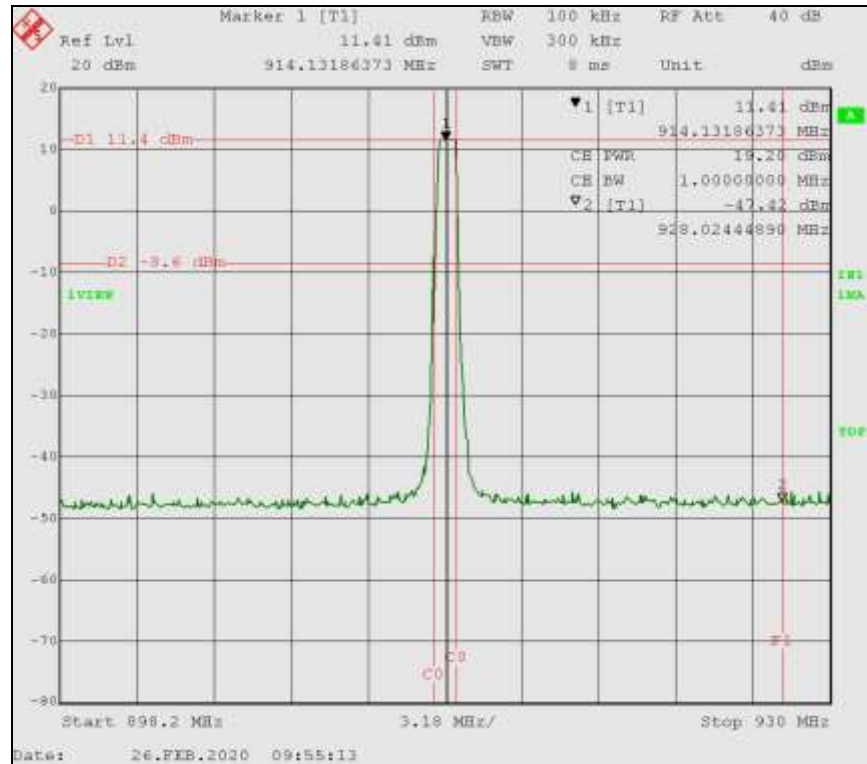


Low Channel 0, 903 MHz, 500 kHz BW, Spread Factor = 12





High Channel 63, 914.2 MHz, 500 kHz BW, Spread Factor = 12



Test Results: The Band Edge measurements of the Woodstream Model V400M LoRa Radio Control Unit LoRa Radio Control Unit show that emissions at the band edges of the Operating Frequency Bandwidth are below the Carrier Peak Level – 20 dB required by 47 CFR Part 15.205.



5.0 Test Setup Photos

See Appendix C Woodstream V400M Test Setup Photos



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	07/02/19	3 Years	07/02/22
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	01/09/19	2 Years	01/09/21
EMC Analyzer (9 kHz - 1.8 GHz)	Hewlett Packard	8593EM	3710A00214	1026	03/02/17	3 Years	03/02/20
Amplifier System (0.5 – 50 GHz)	Hewlett Packard	83015A 83017A	3123A00360 & 3332A00219	1027	10/04/18	2 Years	10/04/20
Double Ridged Horn Antenna (1 - 18 GHz)	EMCO	3115	9705-5225	1028	11/19/18	2 Years	11/19/21
Shielded Room #1	ETS Lindgren	12-2/2-0	4078	859	05/17/18	2 Years	05/17/20
OATS Site (30 MHz – 1 GHz)	BEC	N/A	N/A	705	05/16/19	1 Year	05/16/20
Intentional Radiator Testing High Frequency RF Test Cable	Workhorse	WHU18- 3636-036	N/A	814	12/29/18	2 Years	12/29/20



Temp/Humidity Meter	Control Company	4096	151872672	780	04/08/19	2 Years	04/08/21
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