Certification Test Report

FCC ID: SNA-WFC3
IC: 9458A-WFC3

FCC Rule Part: 15.247
IC Radio Standards Specification: RSS-247

ACS Report Number: 15-2122.W06.1B

Applicant: Woodstream Corporation
Model(s): WFC3

Test Begin Date: **November 19, 2015**
Test End Date: **November 21, 2015**

Report Issue Date: March 14, 2016

FOR THE SCOPE OF ACCREDITATION UNDER CERTIFICATE NUMBER AT-1533

This report must not be used by the client to claim product certification, approval, or endorsement by ANAB, ANSI, or any agency of the Federal Government.

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This report contains 30 pages

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1 GENERAL

1.1 Purpose

The purpose of this report is to demonstrate compliance with Part 15 Subpart C of the FCC's Code of Federal Regulations and Industry Canada's Radio Standards Specification RSS-247.

1.2 Applicant Information

Woodstream Corporation
69 N Locust St
Lititz, PA 17543

1.3 Product Description

The Woodstream Corp. model WFC3 is a component in the Custom-Shape and Radial-Shape Wireless Dog Fence from Havahart®. The system is driven by a nanoLOC TRX 2.4 GHz transceiver that has been enhanced with complex algorithms, strategic distortion filtering and modular signal amplification to deliver advanced time-of-flight-ranging technology and precision event-stamp mapping.

Technical Details

Mode of Operation:	IEEE 802.15.4A
Frequency Range:	2400 MHz - 2483.5 MHz
Number of Channels:	1 (2441.7 MHz)
Modulations:	CSS (Chirp Spread Spectrum)
Antenna Type/Gain:	Flexible Dipole Antenna, 3 dBi
Input Power:	3.0 V CR123A Battery

Model Number: WFC3

Test Sample Serial Number(s): ACS #2, ACS #3, ACS#4, ACS#5

Test Sample Condition: The test samples were provided in good working order with no visible defects.

1.4 Test Methodology and Considerations

The EUT provides two antenna paths which do not transmit simultaneously. The samples used for the testing were pre-configured for transmission on one of the two antenna ports. Four samples were used for the testing corresponding to two radiated emissions units and to two RF conducted units.

The radiated emissions evaluation was performed on samples configured without the collar strap. The EUT was evaluated in three orthogonal orientations. The highest emissions were obtained with the EUT flat on the table top with the antennas facing up. The final measurements were collected for this configuration as the worst case orientation. The results are reported for both antenna ports.

The RF conducted measurements were performed for each antenna port. The samples were configured with a connector for direct coupling to the spectrum analyzer.

The EUT is a battery powered only device with no provision for connection to the AC mains. The device is exempted from the power line conducted emissions requirements.

The EUT was also evaluated for unintentional emissions. The results are documented separately in a Verification test report.

2 TEST FACILITIES

2.1 Location

The radiated and conducted emissions test sites are located at the following address:

Advanced Compliance Solutions, Inc.
3998 FAU Blvd, Suite 310
Boca Raton, Florida 33431
Phone: (561) 961-5585
Fax: (561) 961-5587
www.acstestlab.com

FCC Test Firm Registration #: 475089
Industry Canada Lab Code: 4175C

2.2 Laboratory Accreditations/Recognitions/Certifications

ACS is accredited to ISO/IEC 17025 by ANSI-ASQ National Accreditation Board under their ANAB program and has been issued certificate number AT-1533 in recognition of this accreditation. Unless otherwise specified, all test methods described within this report are covered under the ISO/IEC 17025 scope of accreditation.

2.3 Radiated & Conducted Emissions Test Site Description

2.3.1 Semi-Anechoic Chamber Test Site

The EMC radiated test facility consists of an RF-shielded enclosure. The interior dimensions of the indoor semi-anechoic chamber are approximately 48 feet (14.6 m) long by 36 feet (10.8 m) wide by 24 feet (7.3 m) high and consist of rigid, 1/8 inch (0.32 cm) steel-clad, wood core modular panels with steel framing. In the shielded enclosure, the faces of the panels are galvanized and the chamber is self-supporting. 8-foot RF absorbing cones are installed on 4 walls and the ceiling. The steel-clad ground plane is covered with vinyl flooring.

The turntable is driven by pneumatic motor, which is capable of supporting a 2000 lb. load. The turntable is flush with the chamber floor which it is connected to, around its circumference, with a continuous metallic loaded spring. An EMCO Model 1050 Multi-device controller controls the turntable position.

A pneumatic motor is used to control antenna polarizations and height relative to the ground. The height information is displayed on the control unit EMCO Model 1050.

The control room is an RF shielded enclosure attached to the semi-anechoic chamber with two bulkhead panels for connecting RF, and control cables. The dimension of the room is 7.3 m x 4.9 m x 3 m high and the entrance doors of both control and conducted rooms are 3 feet (0.91 m) by 7 feet (2.13 m).

A diagram of the Semi-Anechoic Chamber Test Site is shown in Figure 2.3.1-1 below:

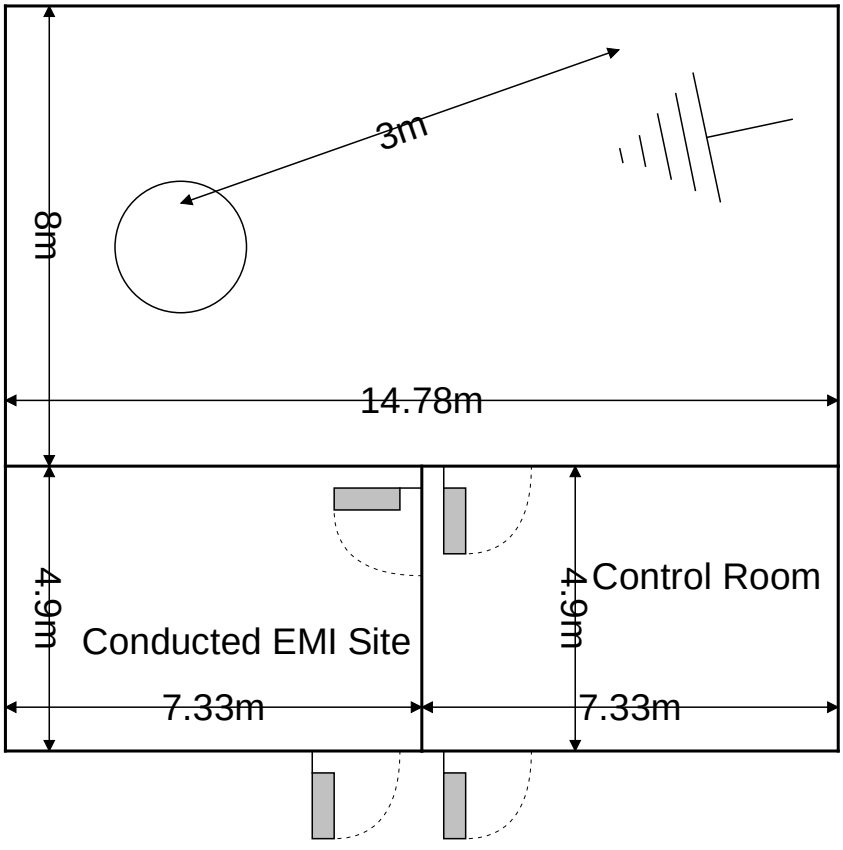


Figure 2.3.1-1: Semi-Anechoic Chamber Test Site

2.3.2 Conducted Emissions Test Site Description

The dimensions of the shielded conducted room are 7.3 x 4.9 x 3 m^3. The power line conducted emission site includes two LISNs: a Solar Model 8028-50 50 Ω/50 µH and an EMCO Model 3825/2R, which are installed as shown in the figure below. For evaluations requiring 230 V, 50 Hz AC input, a Polarad LISN (S/N 879341/048) is used in conjunction with a California Instruments signal generator Model 2001RP-OP1.

A diagram of the room is shown below in figure 2.3.2-1:

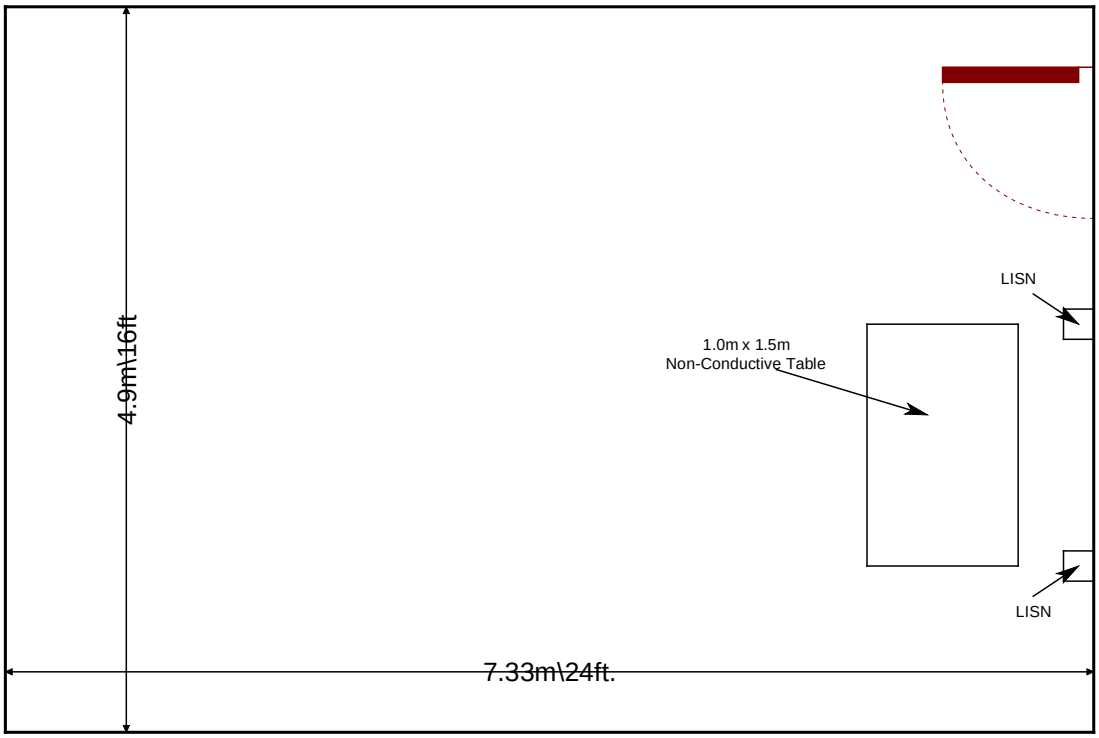


Figure 2.3.2-1: AC Mains Conducted EMI Site

3 APPLICABLE STANDARD REFERENCES

The following standards were used:

- ANSI C63.4-2014: Method of Measurements of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the 9 kHz to 40 GHz.
- ANSI C63.10-2013: American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
- US Code of Federal Regulations (CFR): Title 47, Part 2, Subpart J: Equipment Authorization Procedures, 2016.
- US Code of Federal Regulations (CFR): Title 47, Part 15, Subpart C: Radio Frequency Devices, Intentional Radiators, 2016
- Industry Canada Radio Standards Specification: RSS-247 — Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices, Issue 1, May 2015.
- Industry Canada Radio Standards Specification: RSS-GEN – General Requirements for Compliance of Radio Apparatus, Issue 4, November 2014.

4 LIST OF TEST EQUIPMENT

The calibration interval of test equipment is annually or the manufacturer's recommendations. Where the calibration interval deviates from the annual cycle based on the instrument manufacturer's recommendations, it shall be stated below.

Table 4-1: Test Equipment

AssetID	Manufacturer	Model #	Equipment Type	Serial #	Last Calibration Date	Calibration Due Date
22	Agilent	8449B	Amplifiers	3008A00526	5/18/2015	5/18/2016
RE619	Rhode & Schwarz	ESU26	Spectrum Analyzers	302.6005K26 Ser. 1001	11/5/2014	11/5/2016
479	Electro-Metrics	ALP-70	Antennas	158	12/2/2013	12/2/2015
523	Agilent	E7405	Spectrum Analyzers	MY45103293	12/26/2014	12/26/2016
653	Suhner	SF-102A	Cables	0944/2A	4/13/2015	4/13/2016
2003	EMCO	3108	Antennas	2148	2/18/2014	2/18/2016
2005	FAU EMI R&D Lab	Lazarus	Antennas	EM001	1/27/2014	1/27/2016
2006	EMCO	3115	Antennas	2573	4/14/2015	4/14/2017
2008	COM-Power	AH-826	Antennas	81009	NCR	NCR
2011	Hewlett-Packard	HP 8447D	Amplifiers	2443A03952	11/18/2015	11/18/2016
2070	Mini Circuits	VHF-8400+	Filter	2070	11/17/2015	11/17/2016
2072	Mini Circuits	VHF-3100+	Filter	30737	11/17/2015	11/17/2016
2082	Teledyne Storm Products	90-010-048	Cables	2082	4/22/2015	4/22/2016
2086	Merrimac	FAN-6-10K	Attenuators	23148-83-1	12/31/2014	12/31/2015
2095	ETS Lindgren	TILE4! - Version 4.2.A	Software	85242	NCR	NCR
2121	ACS Boca	Radiated Cable Set	Cable Set	2121	8/22/2015	8/22/2016
2111	Aeroflex Inmet	40AH2W-20	Attenuator	2111	7/22/2015	7/22/2016

Notes:

- **NCR=No Calibration Required**

5 SUPPORT EQUIPMENT

Table 5-1: EUT and Support Equipment

Item #	Type Device	Manufacturer	Model/Part #	Serial #
1	EUT	ACS Design, Inc.	Pet Fence Collar (Woodstream)	ACS#1, ACS#2

Table 5-2: Cable Description

Cable #	Cable Type	Length	Shield	Termination
A	The EUT is Standalone only with no provision for accessory equipment			

6 EQUIPMENT UNDER TEST SETUP BLOCK DIAGRAM

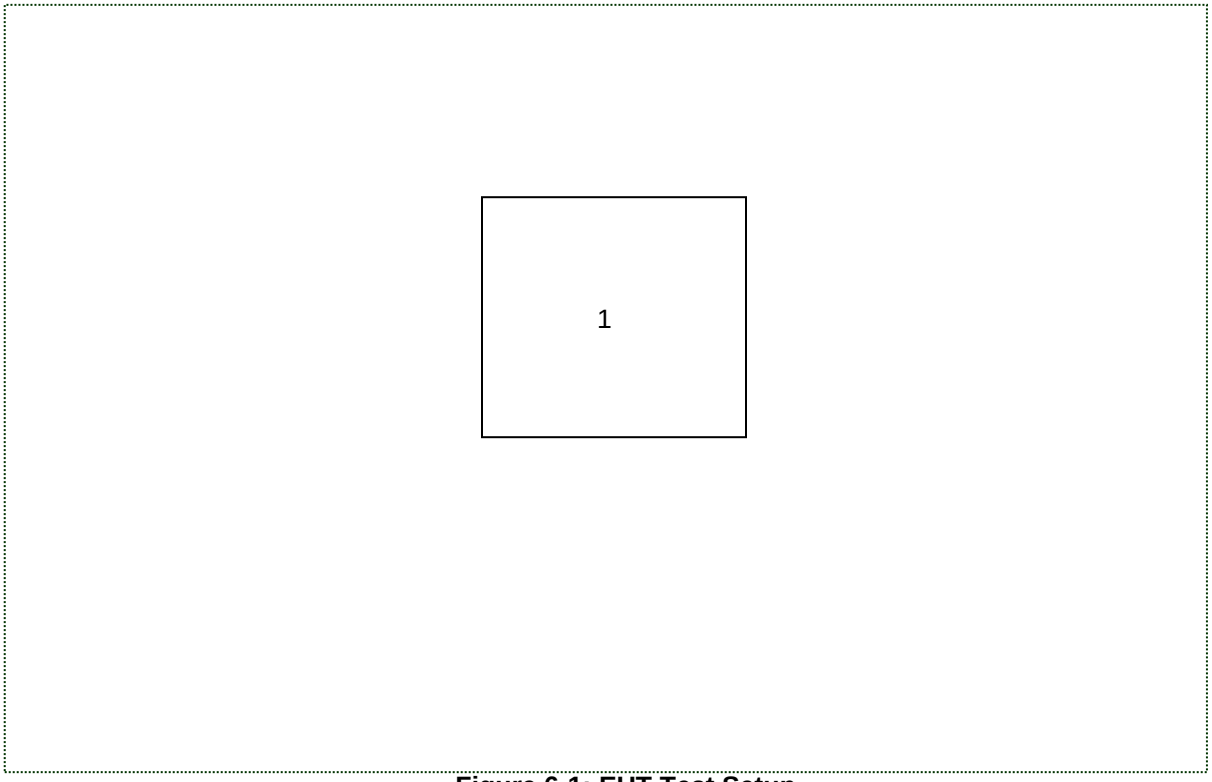


Figure 6-1: EUT Test Setup

7 SUMMARY OF TESTS

Along with the tabular data shown below, plots were taken of all signals deemed important enough to document.

7.1 Antenna Requirement – FCC: Section 15.203

The EUT utilizes Skywave dipole antenna part number 81-3000-A with 3 dBi gain. The antennae are fitted down inside a cavity in the collar straps and use internal u.FL connectors on the PCB. Therefore, the EUT meets the requirements of 15.203 for unique antenna coupling.

7.2 6 dB Bandwidth - FCC: Section 15.247(a)(2) IC: RSS-247 5.5(1); 99% Bandwidth IC: RSS-GEN 6.6

7.2.1 Measurement Procedure

The 6dB bandwidth was measured in accordance with ANSI C63.10:2013 Section 11.8 DTS Bandwidth Option 2. The RBW of the spectrum analyzer was set to 100 kHz and VBW 300 kHz. Span was set large enough to capture the emissions and >> RBW.

The 99% occupied bandwidth was measured with the spectrum analyzer span set to fully display the emission. The RBW was set to 1% to 5% of the approximated bandwidth. The occupied 99% bandwidth was measured by using 99% bandwidth equipment function of the spectrum analyzer.

7.2.2 Measurement Results

Results are shown below.

Antenna Path 1

Table 7.2.2-1: 6dB / 99% Bandwidth

Frequency [MHz]	6dB Bandwidth [MHz]	99% Bandwidth (MHz)
2441.7	58.0128	57.6923

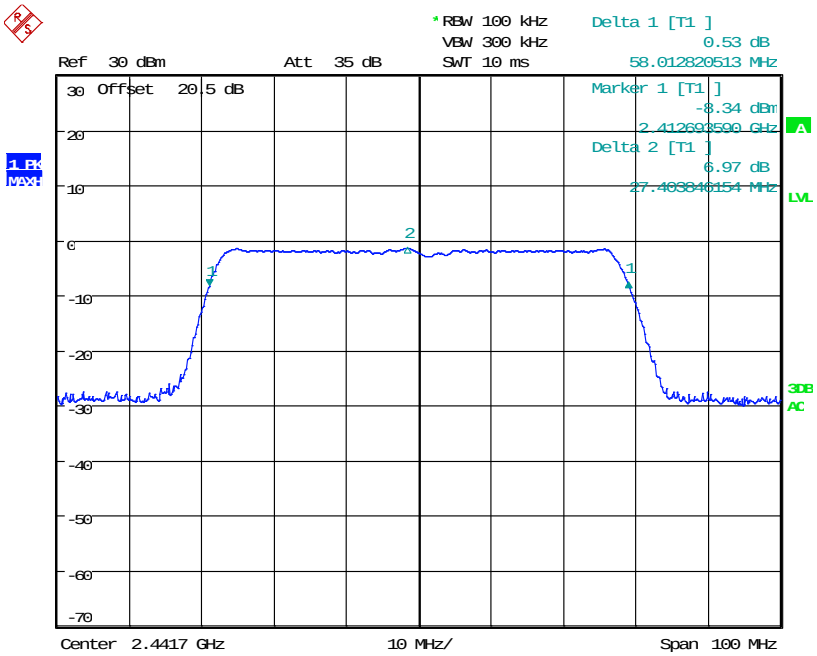


Figure 7.2.2-1: 6dB BW

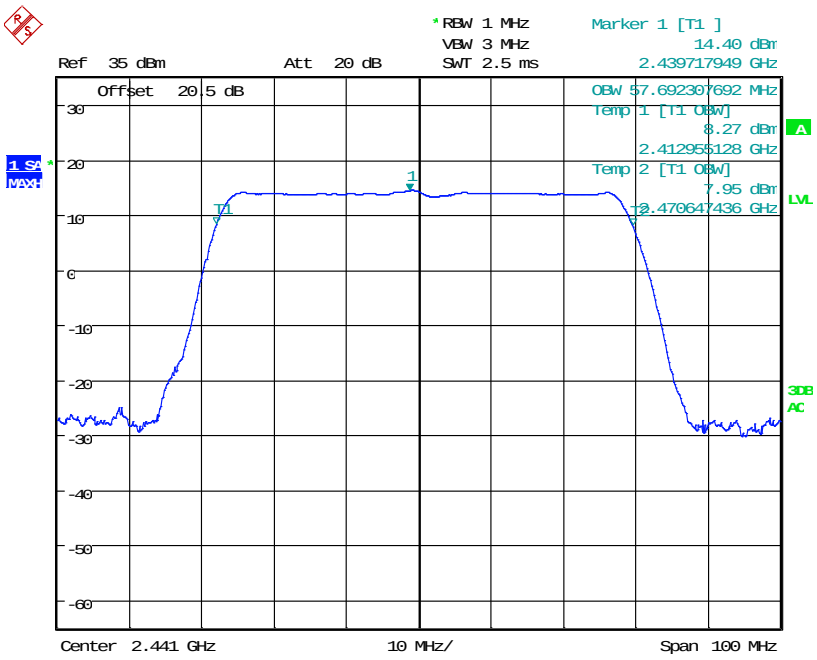


Figure 7.2.2-2: 99% OBW

Antenna Path 2

Table 7.2.2-2: 6dB / 99% Bandwidth

Frequency [MHz]	6dB Bandwidth [MHz]	99% Bandwidth (MHz)
2441.7	58.3333	58.4936

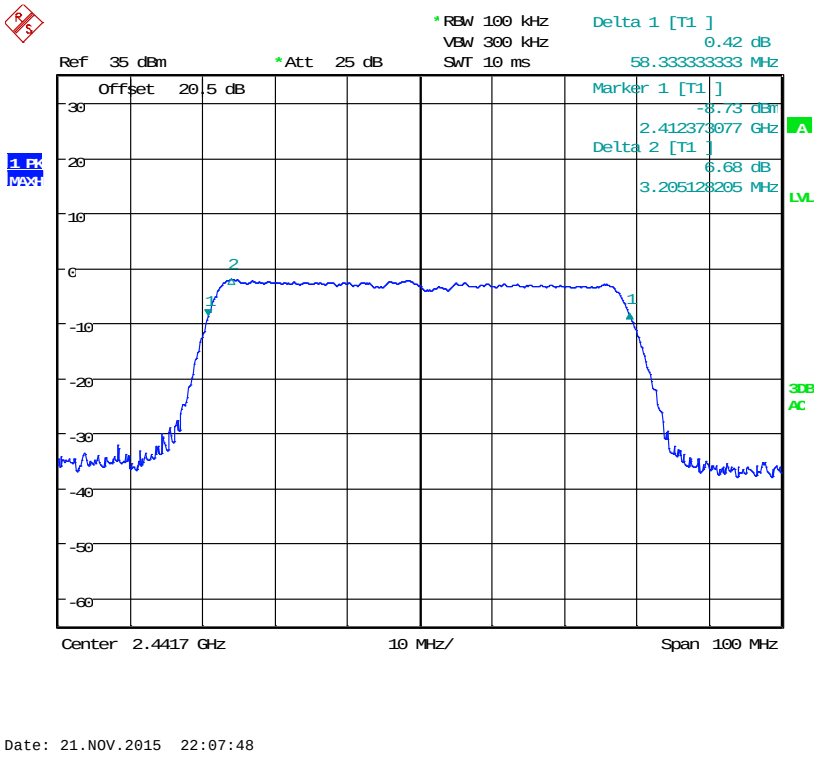


Figure 7.2.2-3: 6dB BW

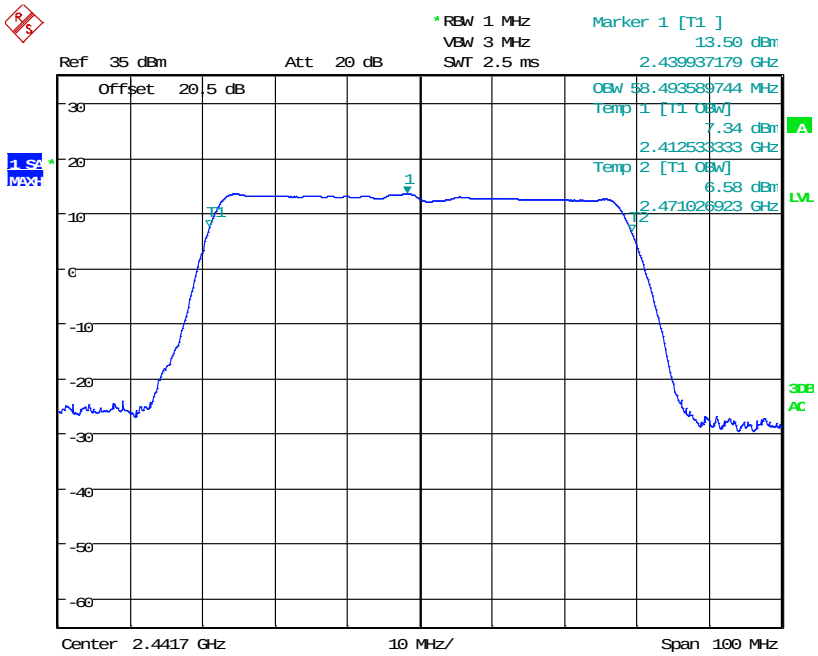


Figure 7.2.2-4: 99% OBW

7.3 Maximum Conducted Output Power - FCC Section 15.247(b)(3) IC: RSS-247 5.4(4)

7.3.1 Measurement Procedure (Conducted Method)

The fundamental emission output power was measured in accordance with ANSI C63.10:2013 Section 11.9.2.2.2 Method AVGSA-1. The RF output of the equipment under test was directly connected to the input of the spectrum analyzer through suitable attenuation.

7.3.2 Measurement Results

Results are shown below.

Antenna Path 1

Table 7.3.2-1: RF Output Power

Frequency [MHz]	Level [dBm]
2441.7	20.77

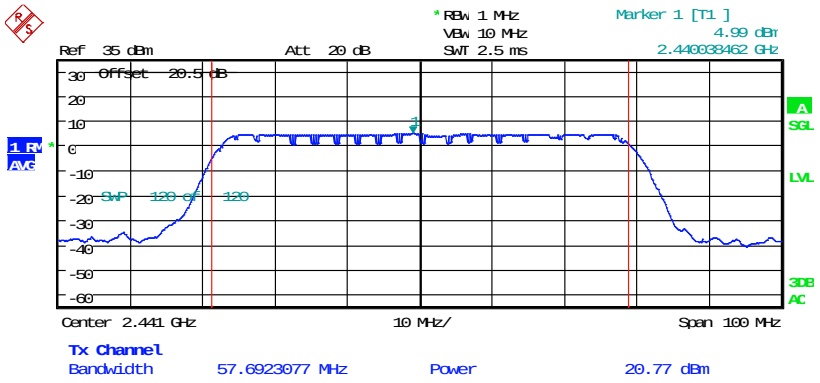


Figure 7.3.2-1: RF Output Power

Antenna Path 2

Table 7.3.2-2: RF Output Power

Frequency [MHz]	Level [dBm]
2441.7	21.52

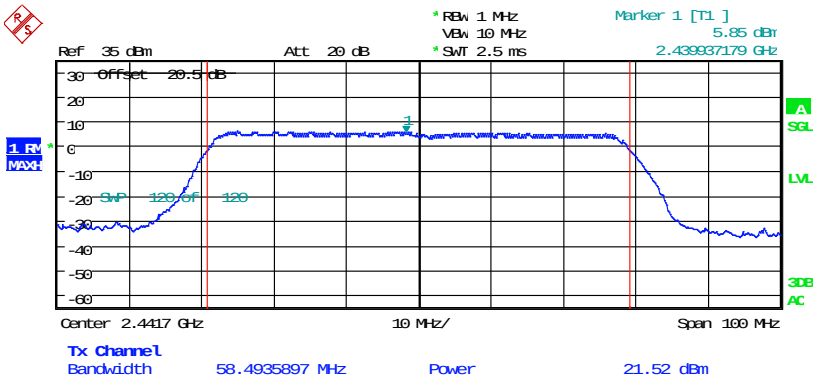


Figure 7.3.2-2: RF Output Power

7.4 Band-Edge Compliance and Spurious Emissions-FCC 15.247(d) IC: RSS-247 5.5

7.4.1 Band-Edge Compliance of RF Conducted Emissions

7.4.1.1 Measurement Procedure

The RF output port of the EUT was directly connected to the input of the spectrum analyzer via suitable attenuation. The EUT was investigated at the lowest and highest channel available to determine band-edge compliance. For each measurement the spectrum analyzer's RBW was set to 100 kHz, and the VBW was set to 300 kHz.

7.4.1.2 Measurement Results

Results are shown below.

Antenna Path 1

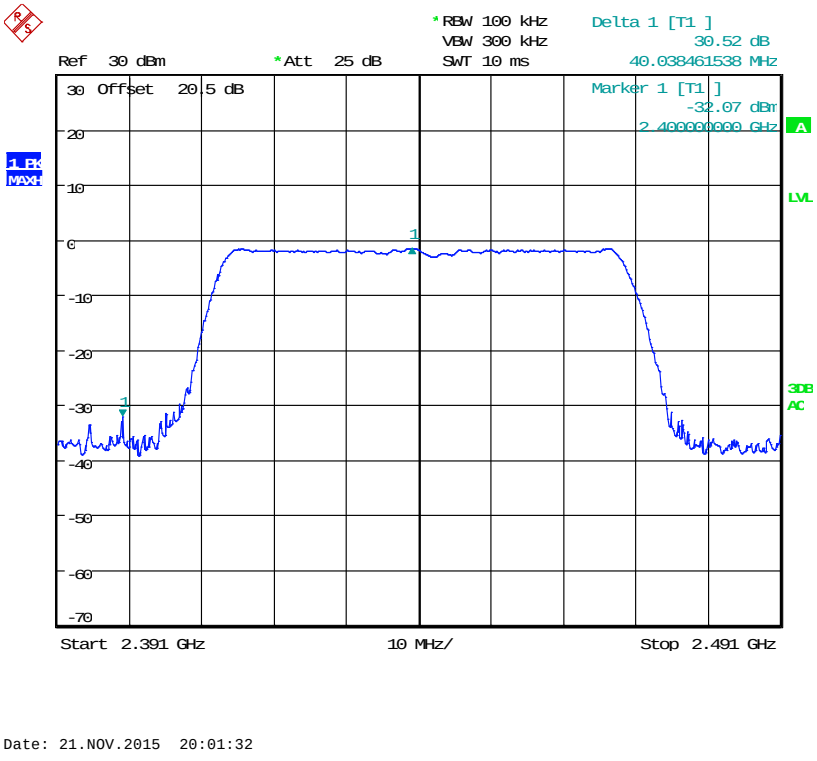


Figure 7.4.1.2-1: Lower Band-edge

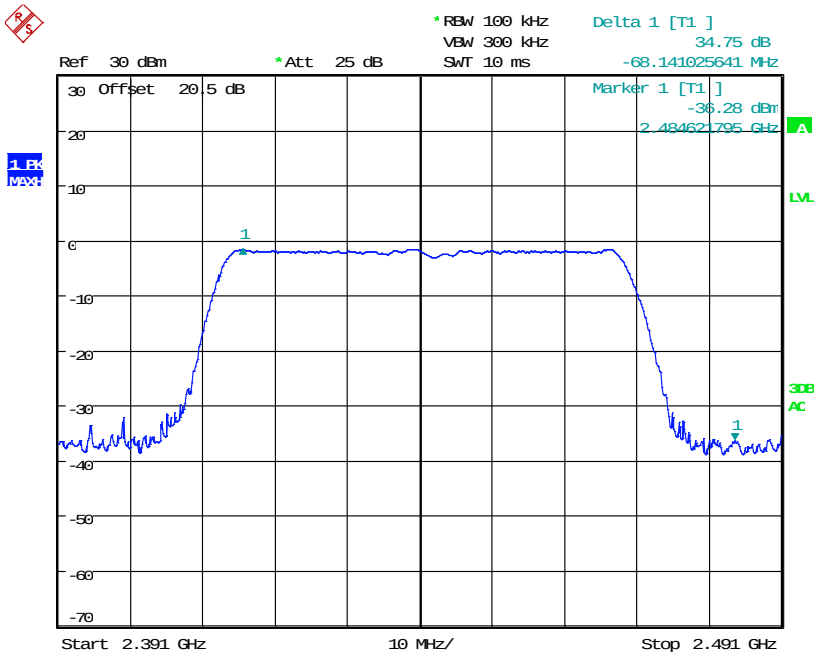


Figure 7.4.1.2-2: Upper Band-edge

Antenna Path 2

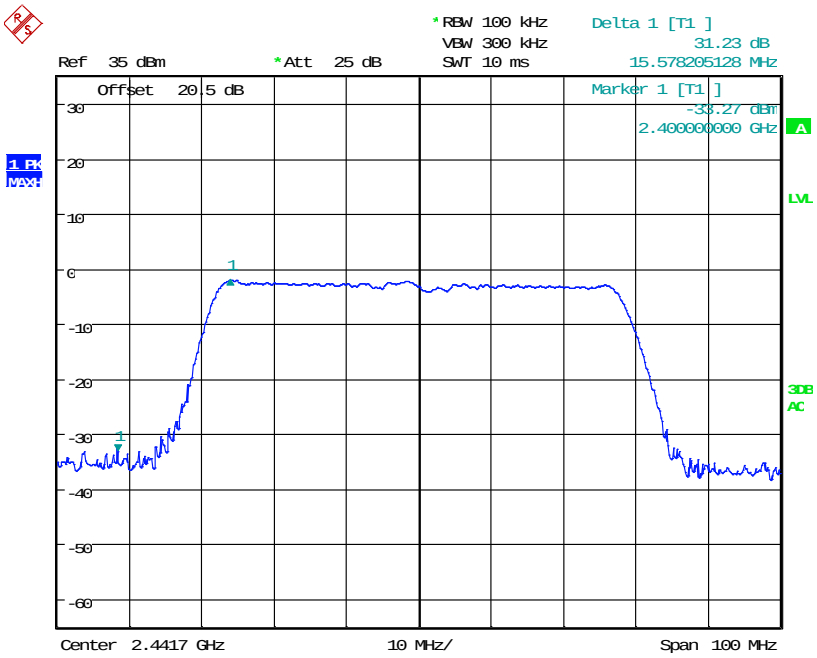


Figure 7.4.1.2-3: Lower Band-edge

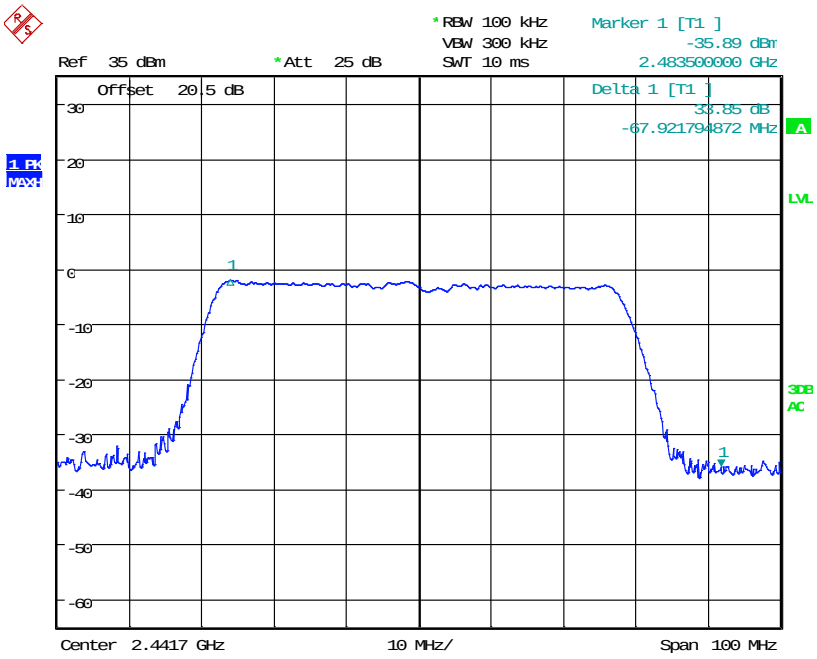


Figure 7.4.1.2-4: Upper Band-edge

7.4.2 RF Conducted Spurious Emissions

7.4.2.1 Measurement Procedure

The RF Conducted Spurious Emissions were measured in accordance with ANSI C63.10:2013 Section 11.11 Emissions in non-restricted frequency bands. The RF output port of the equipment under test was directly connected to the input of the spectrum analyzer. The EUT was investigated for conducted spurious emissions from 30 MHz to 26 GHz, 10 times the highest fundamental frequency. Measurements were made at the low, center and high channels of the EUT. For each measurement, the spectrum analyzer's RBW was set to 100 kHz and the VBW was set to 300 kHz. The peak Max Hold function of the analyzer was utilized. The reference level was determined by measuring the Peak PSD level in any 100 kHz bandwidth within the DTS channel bandwidth.

7.4.2.2 Measurement Results

Results are shown below.

Antenna Path 1

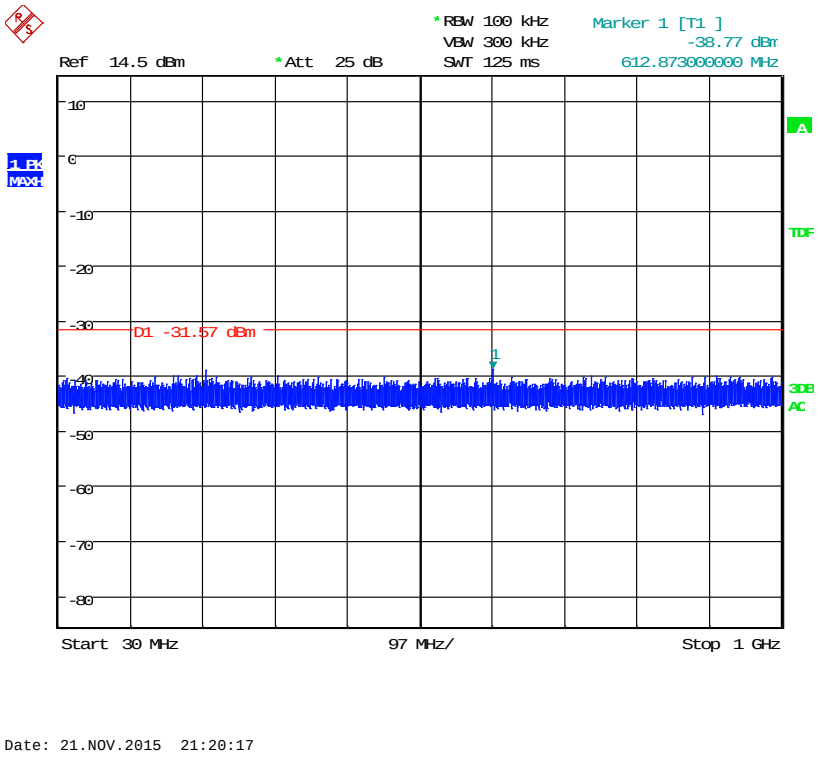


Figure 7.4.2.2-1: 30 MHz – 1 GHz

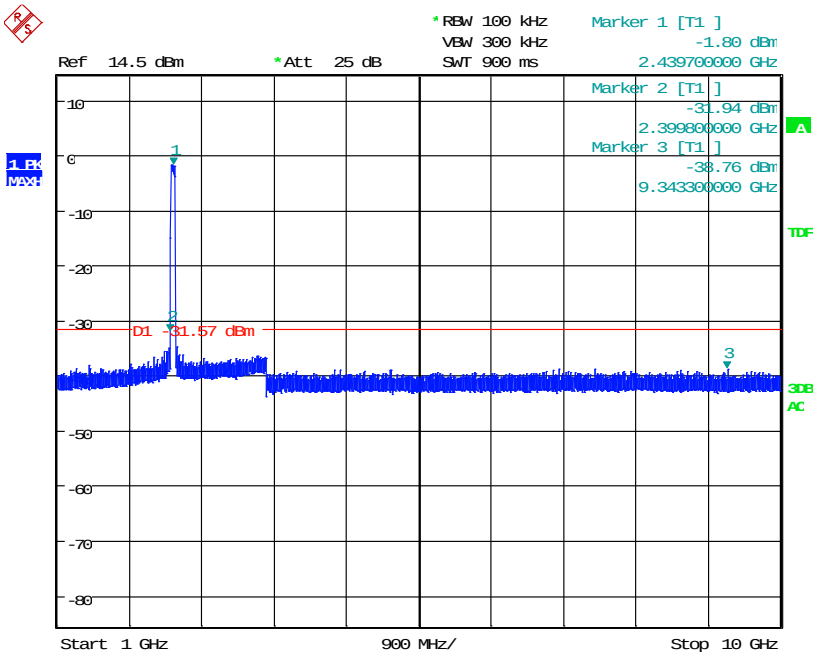


Figure 7.4.2.2-2: 1 GHz –10 GHz

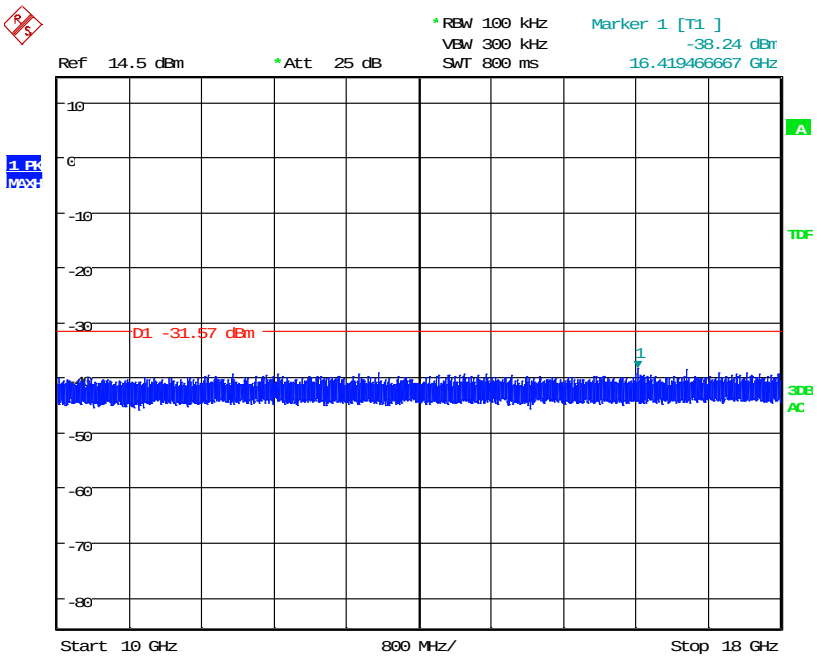
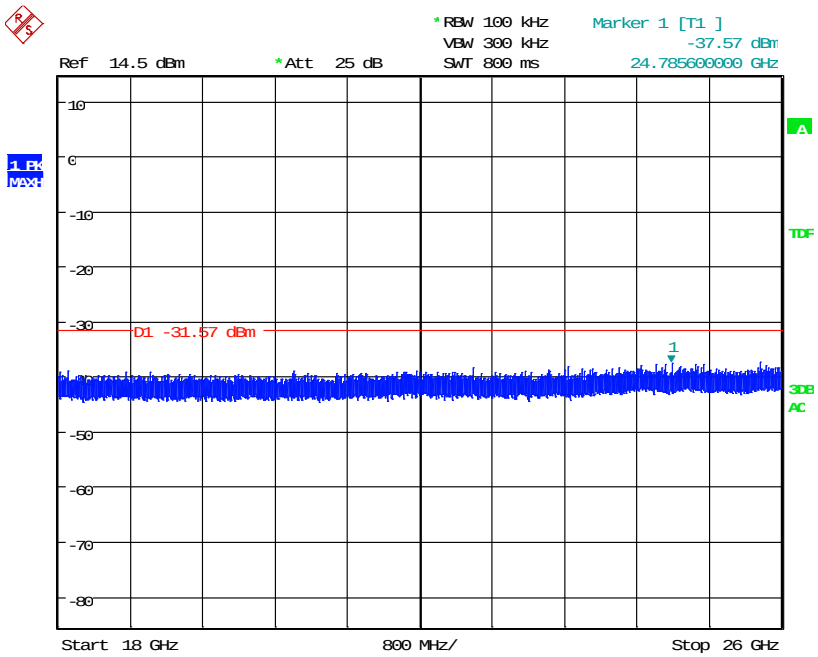


Figure 7.4.2.2-3: 10 GHz –18 GHz



Date: 21.NOV.2015 21:18:08

Figure 7.4.2.2-4: 18 GHz – 26 GHz

Antenna Path 2

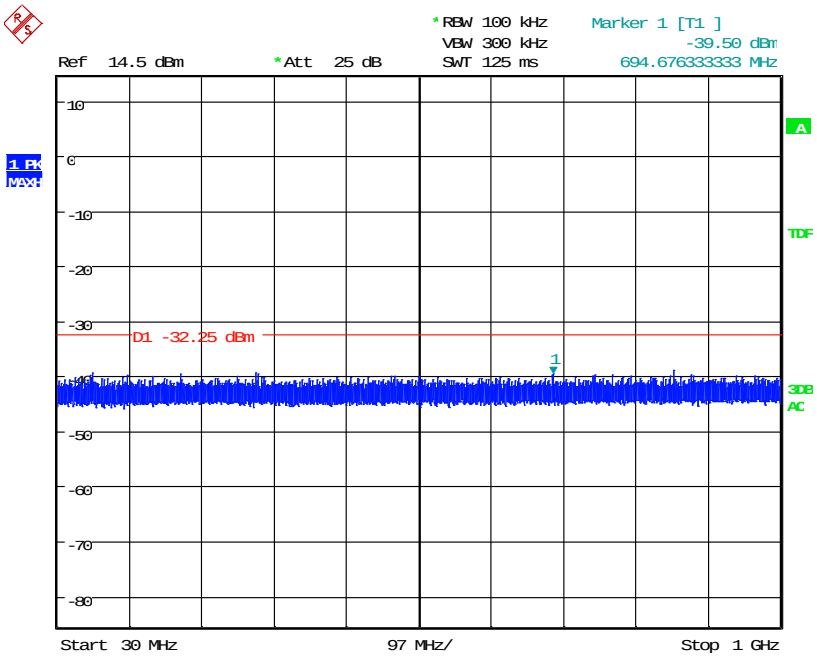


Figure 7.4.2.2-5: 30 MHz – 1 GHz

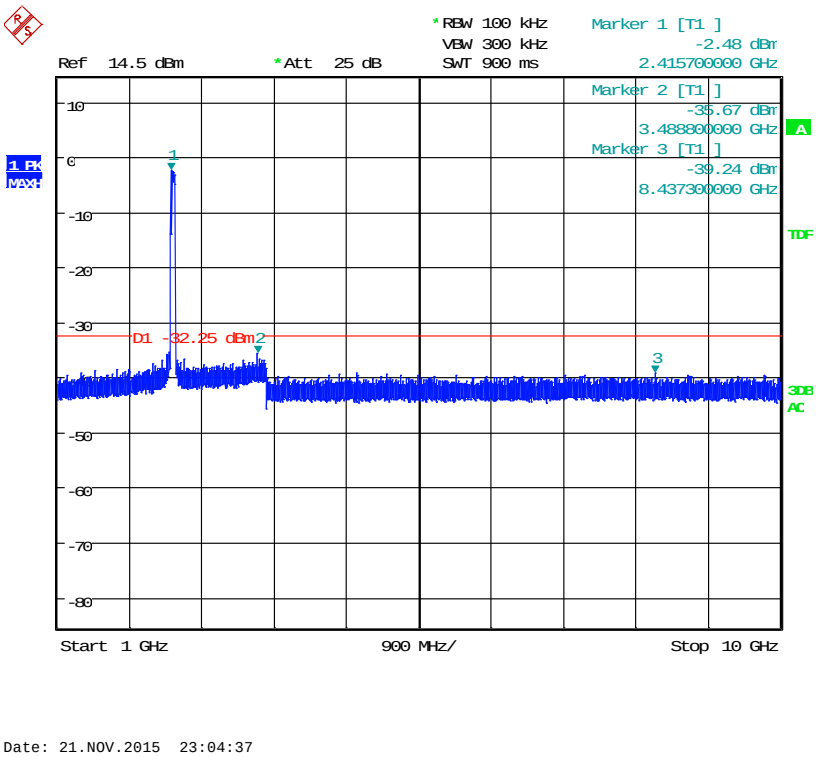


Figure 7.4.2.2-6: 1 GHz –10 GHz

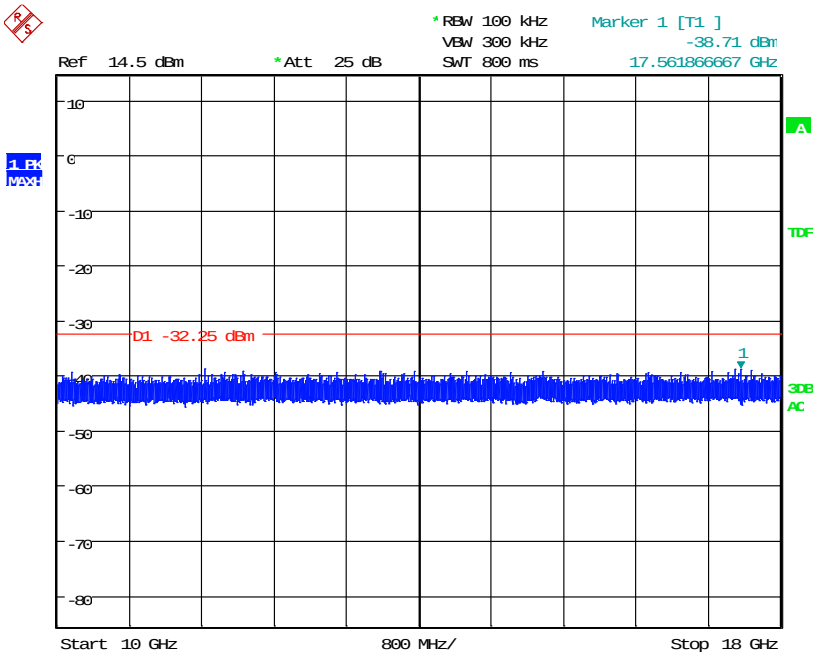


Figure 7.4.2.2-7: 10 GHz –18 GHz

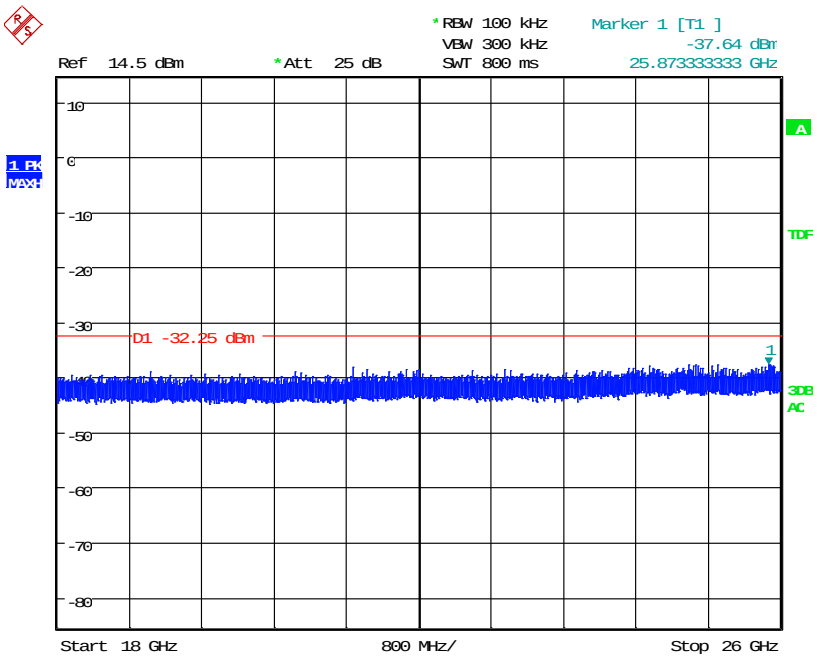


Figure 7.4.2.2-8: 18 GHz – 26 GHz

7.4.3 Radiated Spurious Emissions into Restricted Frequency Bands - FCC 15.205, 15.209; IC: RSS-210 2.2, RSS-Gen 8.9, 8.10

7.4.3.1 Measurement Procedure

Radiated emissions tests were made over the frequency range of 9 kHz to 26 GHz, 10 times the highest fundamental frequency. Each emission found to be in a restricted band as defined by section 15.205, including any emission at the operational band-edge, was compared to the radiated emission limits as defined in section 15.209.

For measurements below 30 MHz, the receive antenna height was set to 1m and the EUT was rotated through 360 degrees. The resolution bandwidth was set to 200 Hz below 150 kHz and to 9 kHz above 150 kHz.

The EUT was rotated through 360° and the receive antenna height was varied from 1m to 4m so that the maximum radiated emissions level would be detected. For frequencies below 1000MHz, quasi-peak measurements were made using a resolution bandwidth RBW of 120 kHz and a video bandwidth VBW of 300 kHz. For frequencies above 1000 MHz, peak measurements are made with RBW of 1 MHz and VBW of 3 MHz. Average measurements are performed in the linear scale using VBW of 30 Hz over a 5 second sweep.

A duty cycle correction factor was used for the measurements. The justification is provided in the equipment's Theory of Operation document.

7.4.3.2 Measurement Results

Radiated band-edge and spurious emissions found in the restricted frequency bands of 9 kHz to 26 GHz are reported in the tables below.

Antenna Path 1

Table 7.4.3.2-1: Radiated Spurious Emissions Tabulated Data

Frequency (MHz)	Level (dBuV)		Antenna Polarity	Correction Factors	Corrected Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
	pk	Qpk/Avg	(H/V)	(dB)	pk	Qpk/Avg	pk	Qpk/Avg	pk	Qpk/Avg
Middle Channel = 2441.7 MHz										
2272.2	58.92	51.12	H	-0.30	58.62	35.92	74.0	54.0	15.4	18.1
2320.175	63.46	45.24	H	-0.05	63.41	30.29	74.0	54.0	10.6	23.7
2336	60.70	51.79	H	0.03	60.73	36.92	74.0	54.0	13.3	17.1
2368.1	66.55	55.60	H	0.19	66.74	40.90	74.0	54.0	7.3	13.1
2368.1	58.5	46.14	V	0.19	58.69	31.44	74.0	54.0	15.3	22.6
2390	67.04	54.24	H	0.31	67.35	39.65	74.0	54.0	6.7	14.3
2484.5	65.73	52.49	H	0.80	66.53	38.39	74.0	54.0	7.5	15.6
2484.5	55.3	41.86	V	0.79	56.09	27.76	74.0	54.0	17.9	26.2
2489.2	64.72	52.73	H	0.82	65.54	38.65	74.0	54.0	8.5	15.3
4883.4	39.98	27.21	H	8.82	48.80	21.13	74.0	54.0	25.2	32.9
4883.4	39.31	26.69	V	8.82	48.13	20.61	74.0	54.0	25.9	33.4
7325.1	49.49	37.37	H	13.67	63.16	36.14	74.0	54.0	10.8	17.9
7325.1	52.75	41.19	V	13.67	66.42	39.96	74.0	54.0	7.6	14.0
12208.5	42.95	30.35	H	20.26	63.21	35.71	83.5	63.5	20.3	27.8
12208.5	42.47	29.45	V	20.26	62.73	34.81	83.5	63.5	20.8	28.7

Note:

- **All the emissions above 12.23 GHz were attenuated below the limits and the noise floor of the measurement equipment.**
- **The average measurements were further corrected using a duty cycle corresponding to 20*log(18/100) = -14.89 dB**
- **The emissions above 10 GHz were performed at a measurement distance of 1m. The limits are corrected accordingly using a distance factor of 20*log(3/1) = 9.54 dB.**

Antenna Path 2

Table 7.4.3.2-2: Radiated Spurious Emissions Tabulated Data

Frequency (MHz)	Level (dBuV)		Antenna Polarity	Correction Factors	Corrected Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
	pk	Qpk/Avg	(H/V)	(dB)	pk	Qpk/Avg	pk	Qpk/Avg	pk	Qpk/Avg
Middle Channel = 2441.7 MHz										
2240	56.85	48.29	V	-0.47	56.38	32.93	74.0	54.0	17.6	21.1
2336	59.5	52.9	H	0.03	59.53	38.03	74.0	54.0	14.5	16.0
2336	63.14	54.29	V	0.03	63.17	39.42	74.0	54.0	10.8	14.6
2374	62.14	50.44	H	0.22	62.36	35.77	74.0	54.0	11.6	18.2
2390	63.14	50.77	V	0.31	63.45	36.18	74.0	54.0	10.6	17.8
2483.5	67.77	53.17	H	0.79	68.56	39.06	74.0	54.0	5.4	14.9
2496	65.7	57.22	H	0.85	66.55	43.18	74.0	54.0	7.4	10.8
2496	52.99	42.06	V	0.85	53.84	28.02	74.0	54.0	20.2	26.0
4883.4	39.23	26.34	H	8.82	48.05	20.26	74.0	54.0	26.0	33.7
4883.4	38.35	25.70	V	8.82	47.17	19.62	74.0	54.0	26.8	34.4
7325.1	46.30	33.47	H	13.67	59.97	32.24	74.0	54.0	14.0	21.8
7325.1	50.64	38.07	V	13.67	64.31	36.84	74.0	54.0	9.7	17.2
12208.5	39.47	26.48	H	20.26	59.73	31.84	83.5	63.5	23.8	31.7
12208.5	40.00	27.09	V	20.26	60.26	32.45	83.5	63.5	23.2	31.0

Note:

- **All the emissions above 12.23 GHz were attenuated below the limits and the noise floor of the measurement equipment.**
- **The average measurements were further corrected using a duty cycle corresponding to 20*log(18/100) = -14.89 dB**
- **The emissions above 10 GHz were performed at a measurement distance of 1m. The limits are corrected accordingly using a distance factor of 20*log(3/1) = 9.54 dB.**

7.4.3.3 Sample Calculation:

$R_C = R_U + CF_T$

Where:

CF_T	=	Total Correction Factor (AF+CA+AG)-DC (Average Measurements Only)
R_U	=	Uncorrected Reading
R_C	=	Corrected Level
AF	=	Antenna Factor
CA	=	Cable Attenuation
AG	=	Amplifier Gain
DC	=	Duty Cycle Correction Factor

Duty Cycle Correction Factor (DC) = 20 *log(18/100) = -14.89 dB

Example Calculation: Peak
Corrected Level: 58.92 + (-0.3) = 58.62 dBµV/m
Margin: 74 dBµV/m – 58.62 dBµV/m = 15.4 dB

Example Calculation: Average
Corrected Level: 51.12 + (-0.3) – 14.89 = 35.93 dBµV/m
Margin: 54 dBµV/m – 35.93 dBµV/m = 18.1 dB

7.5 Power Spectral Density - FCC Section 15.247(e) IC: RSS-247 5.2(2)

7.5.1 PSD Measurement Procedure (Conducted Method)

The power spectral density was measured in accordance with ANSI C63.10:2013 Section 10.2 Method PKPSD (peak PSD). The RF output port of the EUT was directly connected to the input of the spectrum analyzer. Offset values were input for cable and external attenuation. The spectrum analyzer RBW was set to 3 kHz and VBW 10 kHz. Span was adjusted to 1.5 times the 6 dB bandwidth and the sweep time was set to auto.

7.5.2 Measurement Results

Results are shown below.

Antenna Path 1

Table 7.5.2-1: Power Spectral Density

Frequency (MHz)	PSD (dBm)	Limit (dBm)	Margin (dB)
2441.7	-13.25	8.0	21.25

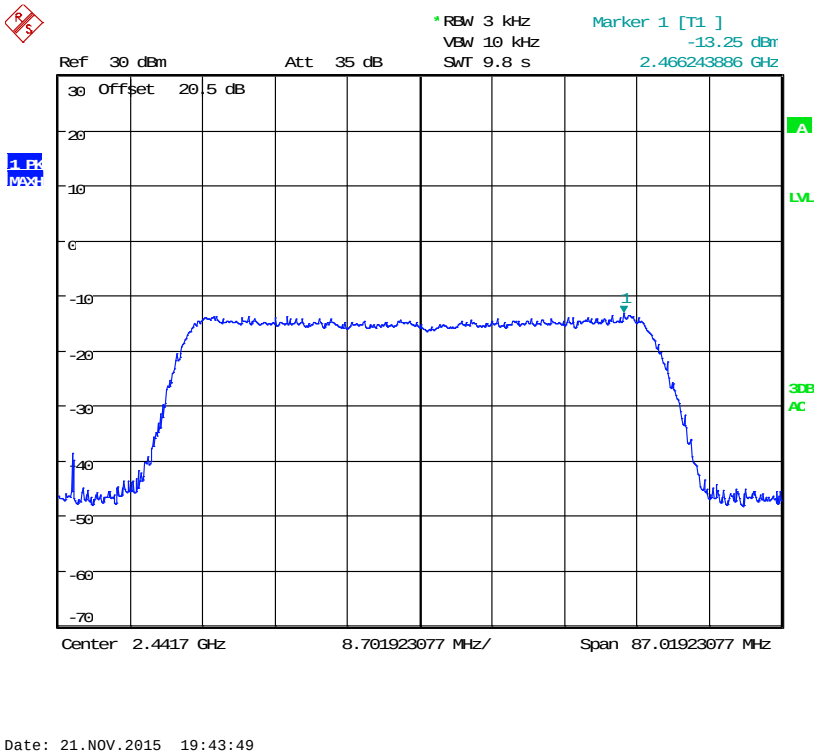


Figure 7.5.2-1: Power Spectral Density

Antenna Path 2

Table 7.5.2-2: Power Spectral Density

Frequency (MHz)	PSD (dBm)	Limit (dBm)	Margin (dB)
2441.7	-14.14	8.0	22.14

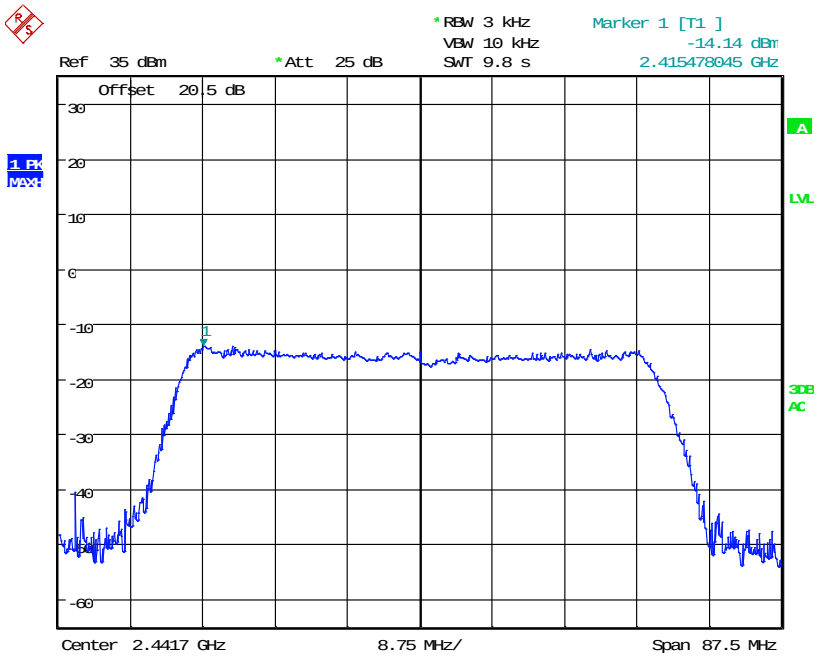


Figure 7.5.2-2: Power Spectral Density

8 CONCLUSION

In the opinion of ACS, Inc., the model WFC3 manufactured by Woodstream Corporation meets the requirements of FCC Part 15 subpart C and Industry Canada's Radio Standards Specification RSS-247 for the test procedures documented in the test report.

END REPORT