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Certification Test Report

FCC ID: RGY-9520
IC: 22290-9520

FCC Rule Part: 15.247
ISED Canada Radio Standards Specification: RSS-247

ACS Report Number: 16-3098.W06.1A

Manufacturer: Roadmaster Inc.
Model: EA066-R

Test Begin Date: November 22, 2016
Test End Date: December 1, 2016

Report Issue Date: February 15, 2017

ANAB ACCREDITED ISO/IEC 17025 TESTING LABORATORY

FOR THE SCOPE OF ACCREDITATION UNDER LAB Code AT-1921

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 18 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 Innovation, Science and Economic Development Canada Standards Specification RSS-247 for Certification.

1.2 Product description

The EA066-R is part of a brake monitoring system used to monitor the brakes of the towed vehicle behind a RV. The EA066-R remote unit is coupled to the Brake Monitor unit residing in a towed car and connects to the monitor unit in the RV with a two-way wireless link using LoRa DTS mode. The device is powered from a respective 12Volt vehicle battery. The remote is operated in transmit mode one time to pair with the Brake Monitor. The system is used to alert RV drivers when braking is occurring in the towed vehicle.

Technical Information:

Detail	Description
Frequency Band	923.42 MHz
Number of Channels	1
Modulation Format	CCS
Data Rates	500 KBPS
Number of Inputs/Outputs	1 Input / 1 Output
Operating Voltage	12 VDC
Antenna Type / Gain	Helical smt / 0.8 dBi

Manufacturer Information:
Roadmaster Inc.
6110 NE 127th Ave.
Vancouver, WA 98682

EUT Serial Numbers: ACS1 for Radiated Measurements and ACS2 for RF Conducted Measurements

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

1.3 Test Methodology and Considerations

All modes of operation, including all available data rates, were evaluated. The data presented in this report represents the worst case where applicable.

The EUT was programmed to continuously transmit on the frequency of interest through the duration of the test.

For Radiated Emissions, the EUT was evaluated in 3 orthogonal orientations. The worst case orientation was in the Y-plane. See test setup photos for more information.

For RF Conducted Emissions, the EUT was modified with a temporary 50 ohm antenna connector for coupling to the measurement equipment.

The EUT is designed for vehicle applications with no provisions for connection to the AC Mains, therefore AC Power Line Conducted Emissions was not performed.

Power setting used during test is +7dBm, +/- 1dBm.

2 TEST FACILITIES

2.1 Location

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

Advanced Compliance Solutions
2320 Presidential Drive, Suite 101
Durham, NC 27703
Phone: (919) 381-4235

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-1921 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.

The Semi-Anechoic Chamber Test Site and Conducted Emissions Site have been fully described, submitted to, and accepted by the FCC and Innovation, Science and Economic Development (ISED) Canada.

FCC Registered Test Site Number: 637011
ISED Canada Test Site Registration Number: 20446

2.3 Radiated Emissions Test Site Description

2.3.1 Semi-Anechoic Chamber Test Site

The Semi-Anechoic Chamber Test Site consists of a 18' x 28' x 18' shielded enclosure. The chamber is lined with Samwha Electronics Co. LTD Ferrite Absorber, model number SFA300 (HSN-1). The ferrite tile is 10cm x 10 cm and weighs approximately 1.4lbs. These tiles are mounted on steel panels and installed directly on the inner walls of the chamber. On top of the ferrite tiles is DMAS HT-45 (Dutch Microwave Absorber Solutions) hybrid absorber on all walls except the wall behind the antenna mast which has a shorter DMAS HT-25 absorber.

The turntable is 1.50m in diameter and is located 150cm from the back wall of the chamber. The chamber is grounded via 1 - 8' copper ground rod, installed at the center of the back wall, it is bound to the ground plane using short #6 copper wire. The turntable is all steel, flush mounted table installed in an all steel frame. The table is remotely operated from inside the control room located 25' from the turntable. The turntable is electrically bonded to the surrounding ground plane via steel fingers installed on the edge of the turn table. The steel fingers make constant contact with the ground plane.

Behind the turntable is a 2' x 6' x 1.5' deep shielded pit used for support equipment if necessary. The pit is equipped with 2 - 4" PVC chase from the turntable to the pit that allow for cabling to the EUT if necessary. The underside of the turntable can be accessed from the pit so cables can be supplied to the EUT from the pit.

A diagram of the Semi-Anechoic Chamber Test Site is shown in Figure 2.3-1 below:

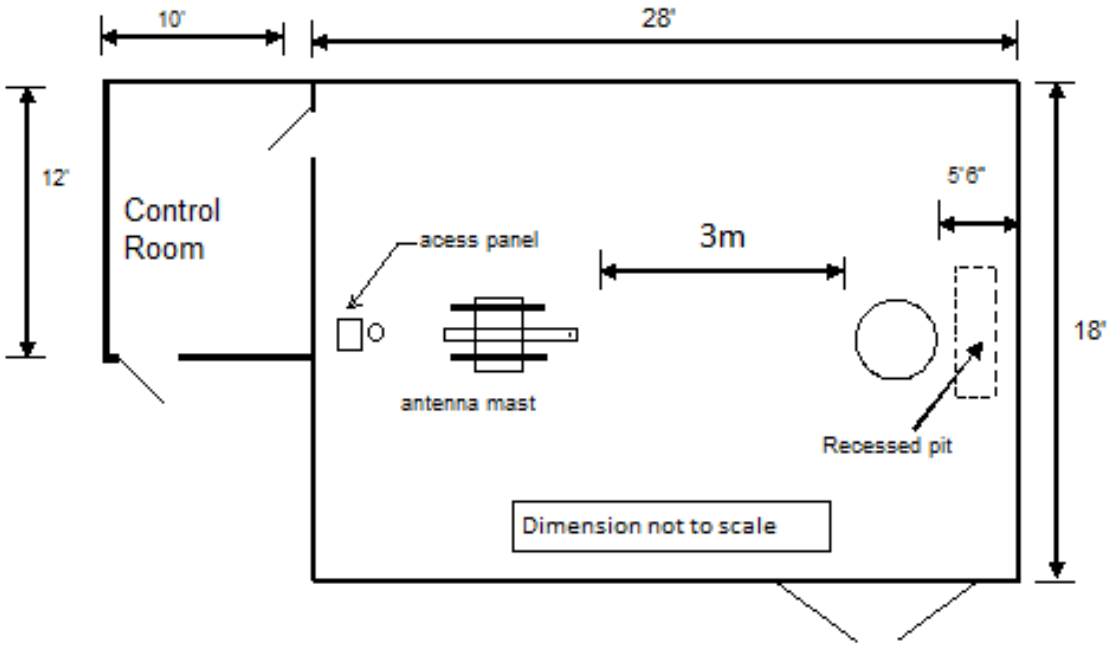

Figure 2.3-1: Semi-Anechoic Chamber Test Site

2.4 Conducted Emissions Test Site Description

The AC mains conducted EMI site is located in the main EMC lab. It consists of an 8' x 10' sheet galvanized steel horizontal ground reference plane (GRP) bonded every 6" to an 8' X 8' aluminum vertical ground plane.

A diagram of the room is shown below in figure 2.4-1:

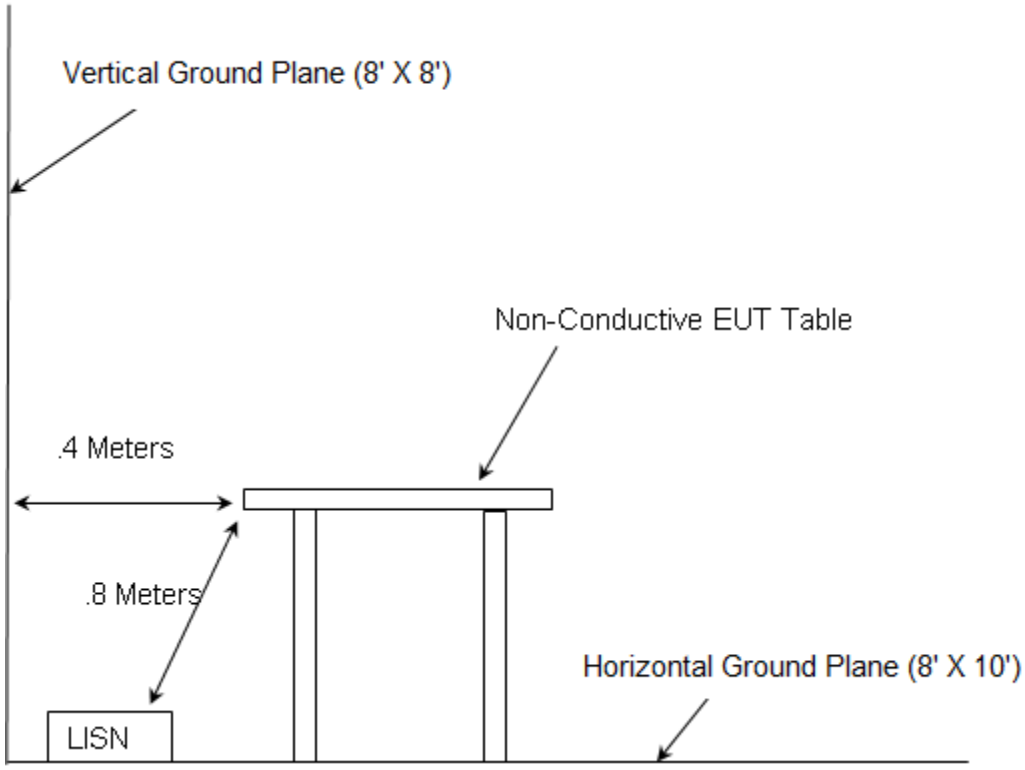

Figure 2.4-1: AC Mains Conducted EMI Site

3 APPLICABLE STANDARD REFERENCES

The following standards were used:

- 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 15, Subpart C: Radio Frequency Devices, Intentional Radiators, 2016
- FCC KDB 558074 D01 DTS Meas Guidance v03r05 - Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247, April 8, 2016
- ISED Canada Radio Standards Specification: RSS-247, Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and License-Exempt Local Area Network (LE-LAN) Devices, Issue 1, May 2015
- ISED Canada Radio Standards Specification: RSS-GEN – General Requirements for Compliance of Radio Apparatus, Issue 4, Nov 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

Asset ID	Manufacturer	Model #	Equipment Type	Serial #	Last Calibration Date	Calibration Due Date
277	EMCO	93146	Antennas	9904-5199	9/12/2016	9/12/2018
626	EMCO	3110B	Antennas	9411-1945	2/29/2016	2/28/2017
3002	Rohde & Schwarz	ESU40	Receiver	100346	1/8/2016	1/8/2017
3006	Rohde & Schwarz	TS-PR18	Amplifiers	122006	6/29/2015	12/29/2016
3008	Rohde & Schwarz	NRP2	Meter	103131	1/28/2016	1/28/2017
3009	Rohde & Schwarz	NRP-Z81	Meter	102397	1/28/2016	1/28/2017
3012	Rohde & Schwarz	EMC32-EB	Software	100731	8/2/2016	2/2/2017
3016	Fei Teng Wireless Technology	HA-07M18G-NF	Antennas	2013120203	1/26/2016	1/26/2018
3038	Florida RF Labs	NMSE-290AW-60.0-NMSE	Cable Set	1448	12/22/2015	12/22/2016
3039	Florida RF Labs	NMSE-290AW-396.0-NMSE	Cable Set	1447	12/22/2015	12/22/2016
3045	Aeroflex Inmet	18N10W-20	Cable Set	1437	1/8/2016	1/8/2017
3055	Rohde & Schwarz	3005	Cables	3055	12/30/2015	12/30/2016
3085	Rohde & Schwarz	FSW43	Spectrum Analyzer	103997	8/9/2016	8/9/2017

NCR = No Calibration Required
DMAS MT-25 RF absorber material was used on the floor for all final measurements above 1 GHz.
Asset 3002: Firmware Version: ESU40 is 4.73 SP4
Asset 3012: Software Version: EMC32-B is 9.15

5 SUPPORT EQUIPMENT

Table 5-1: Support Equipment

Item	Equipment Type	Manufacturer	Model Number	Serial Number
1	EUT	Roadmaster	EA066-R	ACS 1
2	Power Supply	Sorensen	QRD 20-4	2716

Table 5-2: Cable Description

Cable #	Cable Type	Length	Shield	Termination
A	DC Power	1.9 meters	No	2 to 1
B	AC Power	1.2 meters	No	2 to AC

6 EQUIPMENT UNDER TEST SETUP BLOCK DIAGRAM

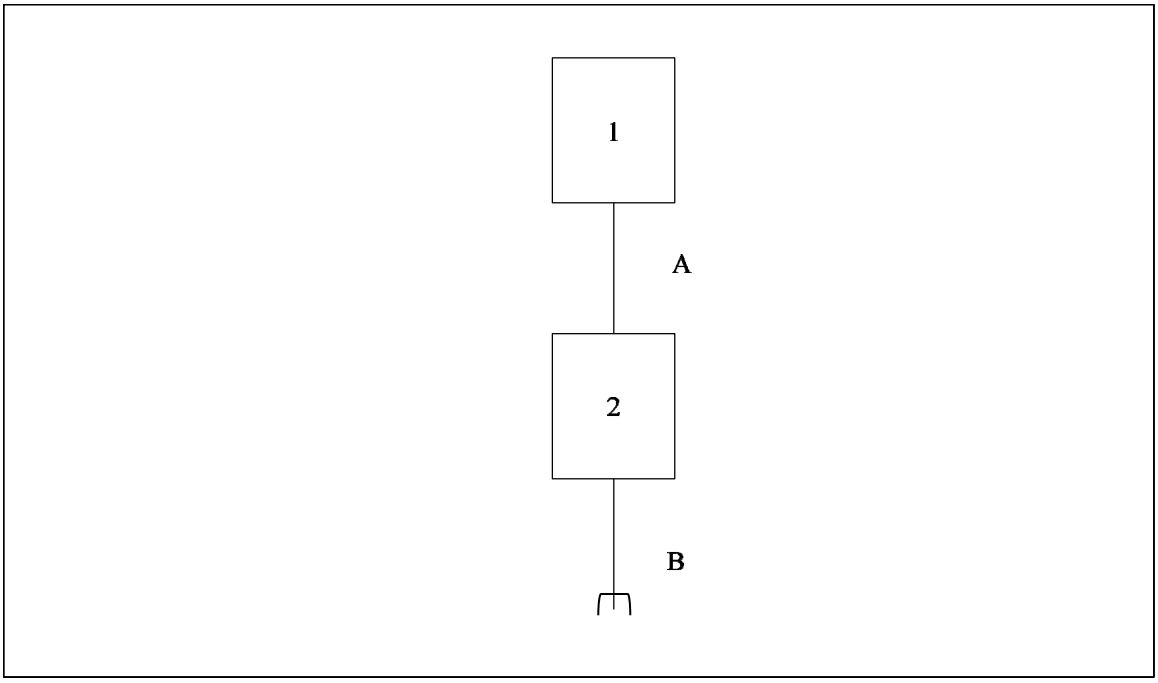

Figure 6-1: Test Setup Block Diagram

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: 15.203

The EUT utilizes a Helical SMT antenna. The antenna is integral to the device and cannot be removed or replaced by the end user. The peak gain of the antenna is 0.8dBi.

7.2 Power Line Conducted Emissions – FCC: 15.207; ISED Canada: RSS-Gen 8.8

7.2.1 Measurement Results

The EUT is vehicle operated only and therefore power line conducted testing is not required.

7.3 Peak Output Power – FCC: 15.247(b)(3); ISED Canada: RSS-247 5.4(2)

7.3.1 Measurement Procedure (Conducted Method)

The maximum peak conducted output power was measured in accordance with FCC KDB 558074 D01 DTS Measurement Guidance v03r05 utilizing the PKPM1 Peak power meter method. The RF output of the equipment under test was directly connected to the input of the peak power meter applying suitable attenuation.
The device employs digital modulation, therefore, the power is limited to 1 Watt.

7.3.2 Measurement Results

Table 7.3.2-1: RF Output Power

Frequency [MHz]	Level [dBm]
923.42	7.92

7.4 6dB / 99% Bandwidth – FCC: 15.247(a)(2); ISED Canada: RSS-247 5.2(1), RSS-Gen 6.6

7.4.1 Measurement Procedure

The 6dB bandwidth was measured in accordance with the FCC KDB 558074 D01 DTS Meas Guidance v03r05. The Resolution Bandwidth (RBW) of the spectrum analyzer was set to 100 kHz. The Video Bandwidth (VBW) was set to ≥ 3 times the RBW. The trace was set to max hold with a peak detector active. The marker-delta function of the spectrum analyzer was utilized to determine the 6 dB bandwidth of the emission.

The occupied bandwidth measurement function of the spectrum analyzer was used to measure the 99% bandwidth. The span of the analyzer was set to capture all products of the modulation process, including the emission sidebands. The resolution bandwidth was set to 1% to 5% of the occupied bandwidth. The video bandwidth was set to 3 times the resolution bandwidth. The trace was set to max hold with a peak detector active.

7.4.2 Measurement Results

Table 7.4.2-1: 6dB / 99% Bandwidth

Frequency (MHz)	6dB Bandwidth (kHz)	99% Bandwidth (kHz)
923.42	733.52	639.79

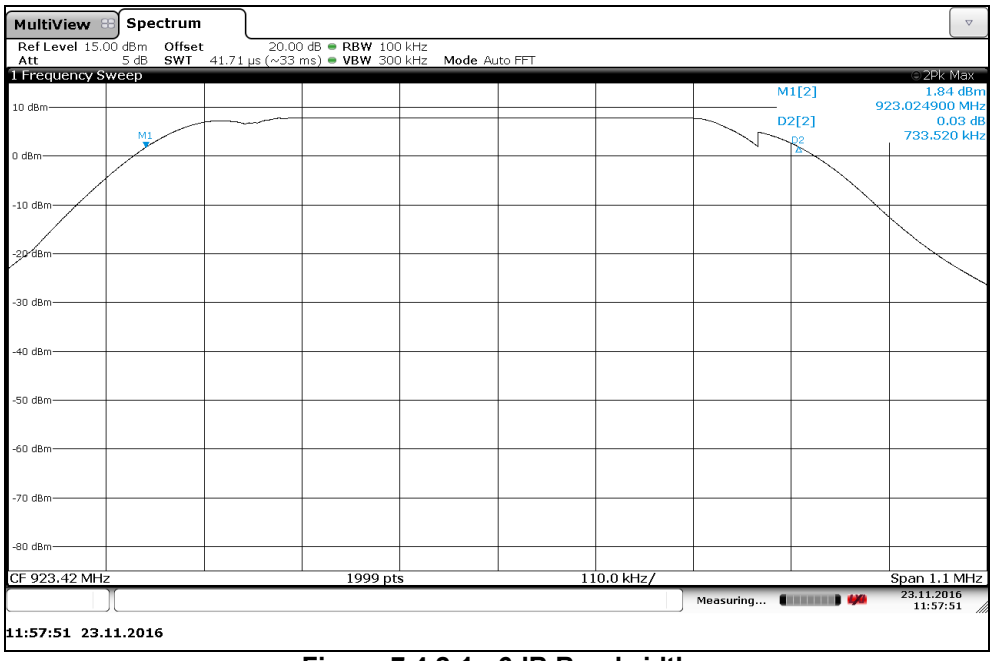

Figure 7.4.2-1: 6dB Bandwidth

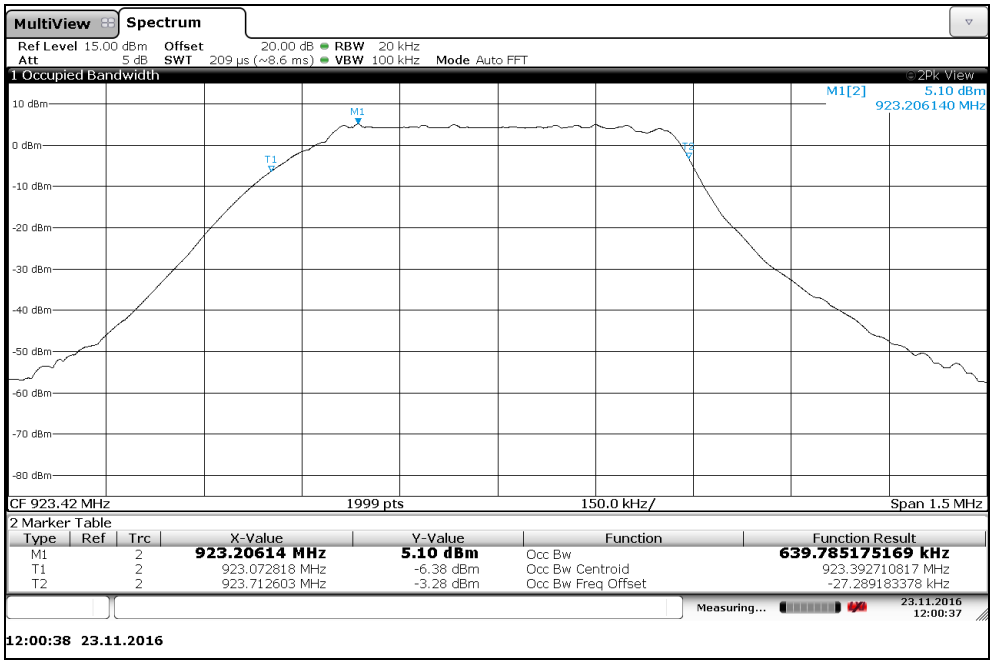

Figure 7.4.2-2: 99% Bandwidth

7.5 Band-Edge Compliance and Spurious Emissions

7.5.1 Band-Edge Compliance of RF Conducted Emissions – FCC: 15.247(d); ISED Canada RSS-247 5.5

7.5.1.1 Measurement Procedure

The unwanted emissions into non-restricted bands were measured conducted in accordance with FCC KDB 558074 D01 DTS Meas Guidance. The RF output of the equipment under test was directly connected to the input of the spectrum analyzer applying suitable attenuation. The Resolution Bandwidth (RBW) of the spectrum analyzer was set to 100 kHz. The Video Bandwidth (VBW) was set to ≥ 300 kHz. Span was set to 1.5 times the DTS bandwidth. The trace was set to max hold with a peak detector active. The resulting spectrum analyzer peak level was used to determine the reference level with respect to the 20 dBc limit.

Band-edge compliance was determined using the conducted marker-delta method in which the radio frequency power that is produced by the EUT is at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of desired power.

7.5.1.2 Measurement Results

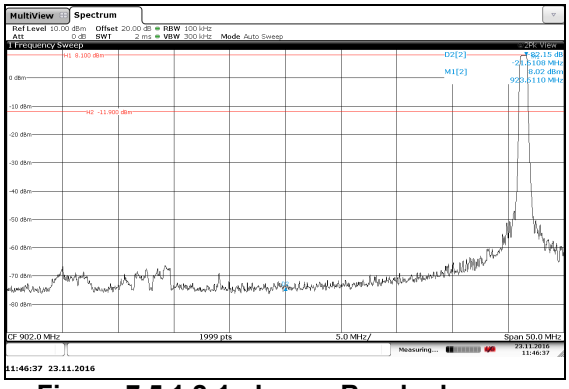

Figure 7.5.1.2-1: Lower Band-edge

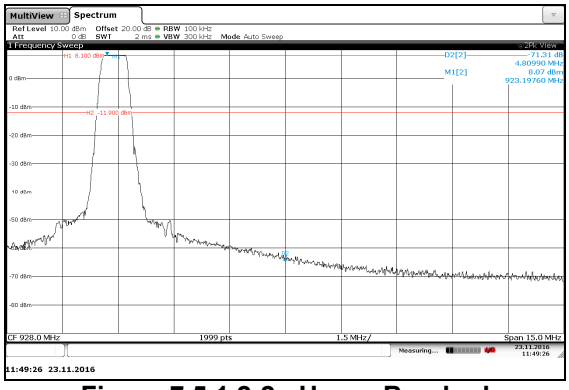

Figure 7.5.1.2-2: Upper Band-edge

7.5.2 RF Conducted Spurious Emissions – FCC: 15.247(d); ISED Canada RSS-247

7.5.2.1 Measurement Procedure

The unwanted emissions into non-restricted bands were measured conducted in accordance with FCC KDB 558074 D01 DTS Meas Guidance. The RF output of the equipment under test was directly connected to the input of the spectrum analyzer applying suitable attenuation. The Resolution Bandwidth (RBW) of the spectrum analyzer was set to 100 kHz. The Video Bandwidth (VBW) was set to ≥ 300 kHz. Span was set to 1.5 times the DTS bandwidth. The trace was set to max hold with a peak detector active. The resulting spectrum analyzer peak level was used to determine the reference level with respect to the 20 dBc limit. The spectrum span was then adjusted for the measurement of spurious emissions from 30MHz to 10GHz, 10 times the highest fundamental frequency.

7.5.2.2 Measurement Results

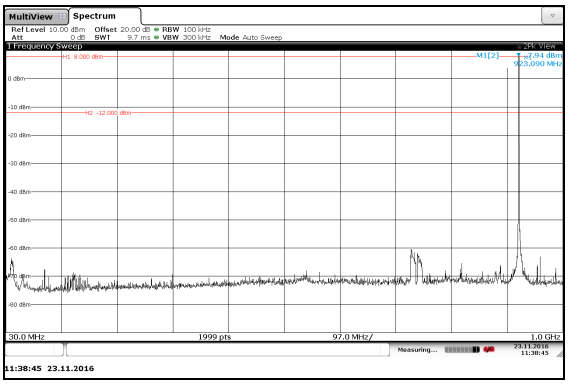

Figure 7.5.2.2-1: 30 MHz – 1 GHz – Conducted Emissions

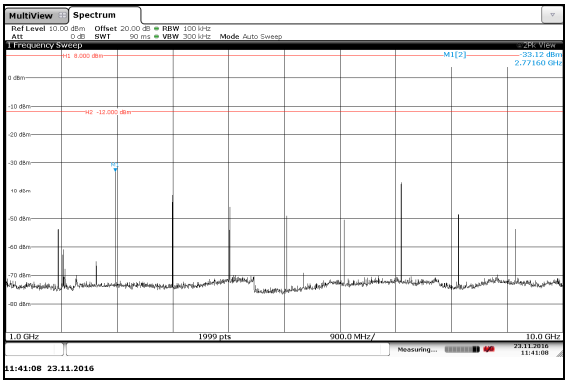

Figure 7.5.2.2-2: 1 GHz – 10 GHz – Conducted Emissions

7.5.3 Radiated Spurious Emissions into Restricted Frequency Bands – FCC: 15.205, 15.209; ISED Canada RSS-Gen 8.9/8.10

7.5.3.1 Measurement Procedure

Radiated emissions tests were made over the frequency range of 30MHz to 10GHz, 10 times the highest fundamental frequency.

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 1000MHz, peak and average measurements were made with RBW and VBW of 1 MHz and 3MHz respectively. The average emissions were further corrected by applying the duty cycle correction of the EUT for comparison to the average limit.

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.

7.5.3.2 Duty Cycle Correction

For average radiated measurements, using a 18% duty cycle, the measured level was reduced by a factor 14.89dB. The duty cycle correction factor is determined using the formula: 20log (18/100) = - 14.89dB.

A detailed analysis of the duty cycle timing is provided in the Theory of Operation accompanying the application for certification.

7.5.3.3 Measurement Results

Table 7.5.3.3-1: 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
2770.2	59.00	51.40	H	-0.33	58.67	36.18	74.0	54.0	15.3	17.8
2770.2	53.70	45.70	V	-0.33	53.37	30.48	74.0	54.0	20.6	23.5
3693.6	45.90	34.40	H	3.75	49.65	23.25	74.0	54.0	24.4	30.7
3693.6	47.90	37.30	V	3.75	51.65	26.15	74.0	54.0	22.4	27.8
4617	49.50	37.60	H	6.12	55.62	28.83	74.0	54.0	18.4	25.2
4617	50.10	38.30	V	6.12	56.22	29.53	74.0	54.0	17.8	24.5
7387.2	56.60	41.70	H	9.27	65.87	36.07	74.0	54.0	8.1	17.9
7387.2	61.40	46.50	V	9.27	70.67	40.87	74.0	54.0	3.3	13.1
8310.6	51.80	36.20	H	11.51	63.31	32.82	74.0	54.0	10.7	21.2
8310.6	49.60	34.10	V	11.51	61.11	30.72	74.0	54.0	12.9	23.3

7.5.3.4 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

Example Calculation: Peak

Corrected Level: 45.90 + 3.75 = 49.65dBuV/m
Margin: 74dBuV/m – 49.65dBuV/m = 24.4dB

Example Calculation: Average

Corrected Level: 37.60 + 6.12 - 14.89 = 28.83dBuV/m
Margin: 54dBuV/m – 28.8dBuV/m = 25.2dB

7.6 Maximum Power Spectral Density – FCC: 15.247(e); ISED Canada: RSS-247 5.2(2)

7.6.1 Measurement Procedure

The power spectral density was measured in accordance with the FCC KDB 558074 D01 DTS Meas Guidance v03r05 utilizing the PKPSD (peak PSD) method. The RF output of the equipment under test was directly connected to the input of the spectrum analyzer applying suitable attenuation. The Resolution Bandwidth (RBW) of the spectrum analyzer was set to 3 kHz. The Video Bandwidth (VBW) was set to 10 kHz. Span was set to 1.5 times the DTS bandwidth. The trace was set to max hold with a peak detector active.

7.6.2 Measurement Results

Table 7.6.2-1: Peak Power Spectral Density

Frequency (MHz)	PSD Level (dBm)
923.42	-4.38

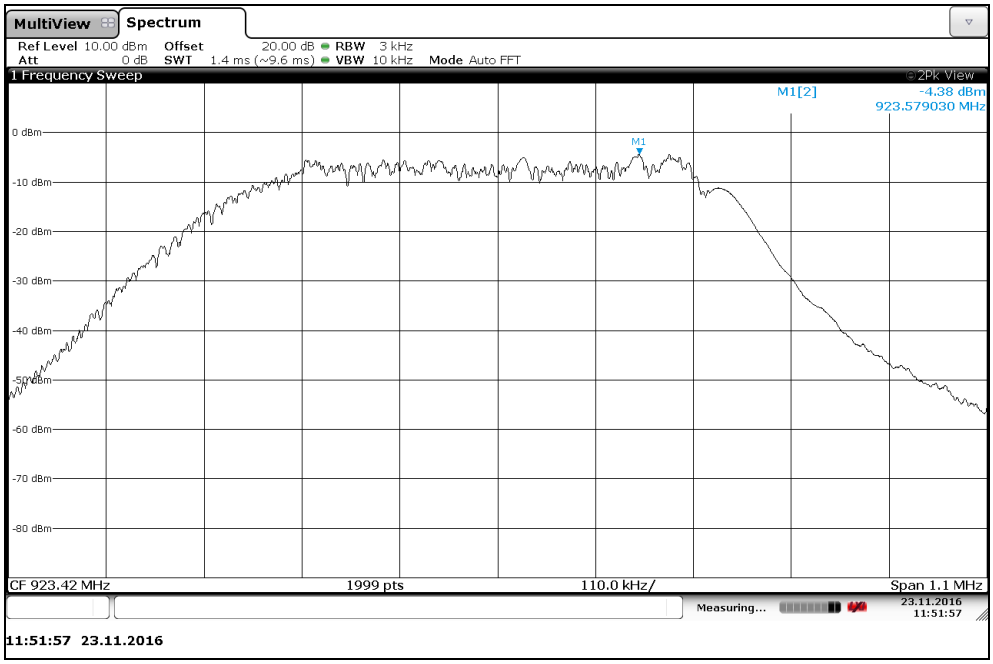

Figure 7.6.2-1: Power Spectral Density

8 CONCLUSION

In the opinion of ACS, Inc. the EA066-R, manufactured by Roadmaster Inc. meets the requirements of FCC Part 15 subpart C and ISED Canada's Radio Standards Specification RSS-247 for the tests documented herein.

END REPORT