



Certification Test Report

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IC: 11454A-EA095

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

TÜV SÜD AMERICA, INC. Report Number: 16-2086.W06.1C

Applicant: JL MARINE SYSTEMS, INC.

Model(s): PUMP-CM2-8-BLS

Test Begin Date: **December 15, 2017**
Test End Date: **February 7, 2017**

Report Issue Date: August 1, 2018



FOR THE SCOPE OF ACCREDITATION UNDER CERTIFICATE NUMBER 2955.15

This report must not be used by the client to claim product certification, approval, or endorsement by A2LA, ANSI, or any agency of the Federal Government.

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This report contains 25 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's Radio Standards Specification RSS-247 for the tests documented herein.

1.2 Applicant Information

JL MARINE SYSTEMS, INC.
9010 Palm River Rd
Tampa, FL 33619

1.3 Product Description

The JL MARINE SYSTEMS, INC. CM2 Motor Board model PUMP-CM2-8-BLS is a boat mounted hydraulic pump operator for robotic boat anchor powered by the boat's 12 VDC battery. The device includes a 900 MHz ISM transceiver. The PCB of the device also includes a BM78 Bluetooth Module (FCC ID A8TBM78ABCDEFGH/IC:12246A-BM78SPPS5M2). The Bluetooth and 900 MHz radios are not capable of transmitting simultaneously.

Technical Details

Mode of Operation: 900 MHz ISM
Frequency Range: 921.23 MHz - 922.73 MHz
Number of Channels: 2
Channel Separation: 1.5 MHz
Modulations: 2-GFSK
Antenna Type/Gain: PCB Printed Antenna, 0.8 dBi
Input Power: 12 VDC

Model Number: PUMP-CM2-8-BLS

Test Sample Serial Number(s): N/A

Test Sample Condition: The equipment was provided in good condition without any physical damage.

1.4 Test Methodology and Considerations

The EUT was evaluated for radiated and RF conducted emissions. The EUT is battery powered by a boat's 12 VDC battery and does not offer provisions for connection to the AC Mains. The EUT is exempted from the power line conducted emissions requirements.

The EUT was evaluated for radiated emissions in the orientation of typical installation.

The RF Conducted Emissions measurements were performed on a sample configured with an SMA connector at the RF port for direct coupling to the spectrum analyzer.

The EUT was also investigated 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:

TÜV SÜD America, Inc.
3998 FAU Blvd, Suite 310
Boca Raton, Florida 33431
Phone: (561) 961-5586
Fax: (561) 961-5587
<http://www.tuv-sud-america.com>

Innovation, Science and Economic Development Canada Lab Code: 4175C

2.2 Laboratory Accreditations/Recognitions/Certifications

TÜV SÜD America, Inc. is accredited to ISO/IEC 17025 by American Association for Laboratory Accreditation (A2LA) and has been issued certificate number 2955.15 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.

Main Site Information:

TÜV SÜD America, Inc.
5610 West Sligh Ave., Suite 100
Tampa, Florida 33634
Phone: 813-284-2715
www.tuv-sud-america.com

FCC Designation Number US1063
FCC Test Firm Registration #: 160606
Innovation, Science, and Economic Development Canada Lab Code: 2087A-2

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 1060 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:

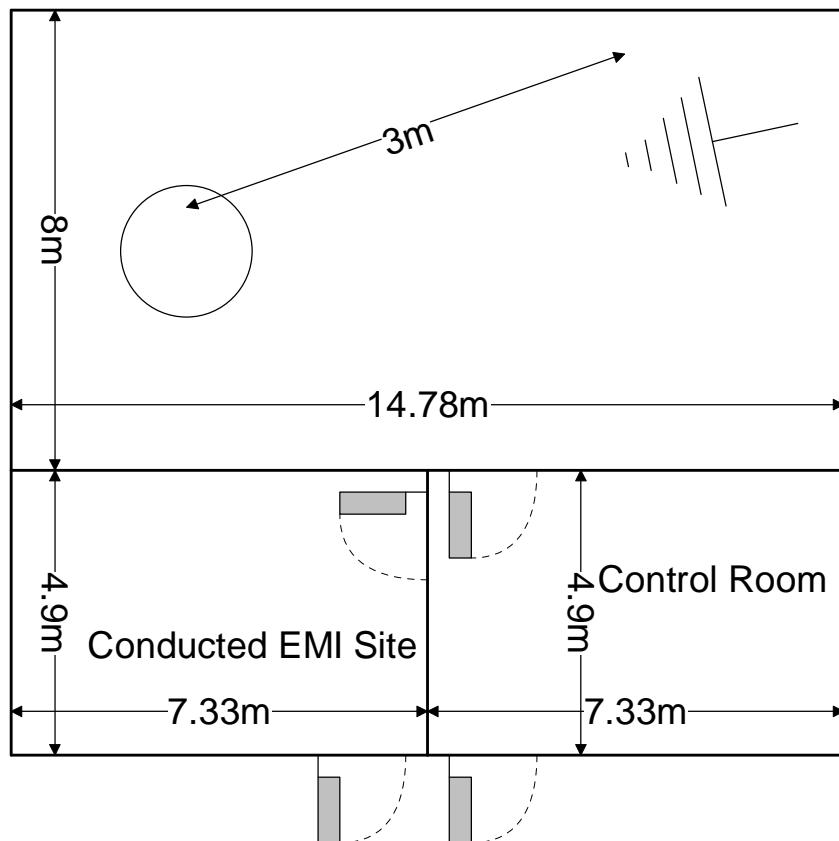


Figure 2.3.1-1: Semi-Anechoic Chamber Test Site

2.3.2 Conducted Emissions Test Site Description

The dimensions of the shielded conducted room are $7.3 \times 4.9 \times 3 \text{ m}^3$. 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:

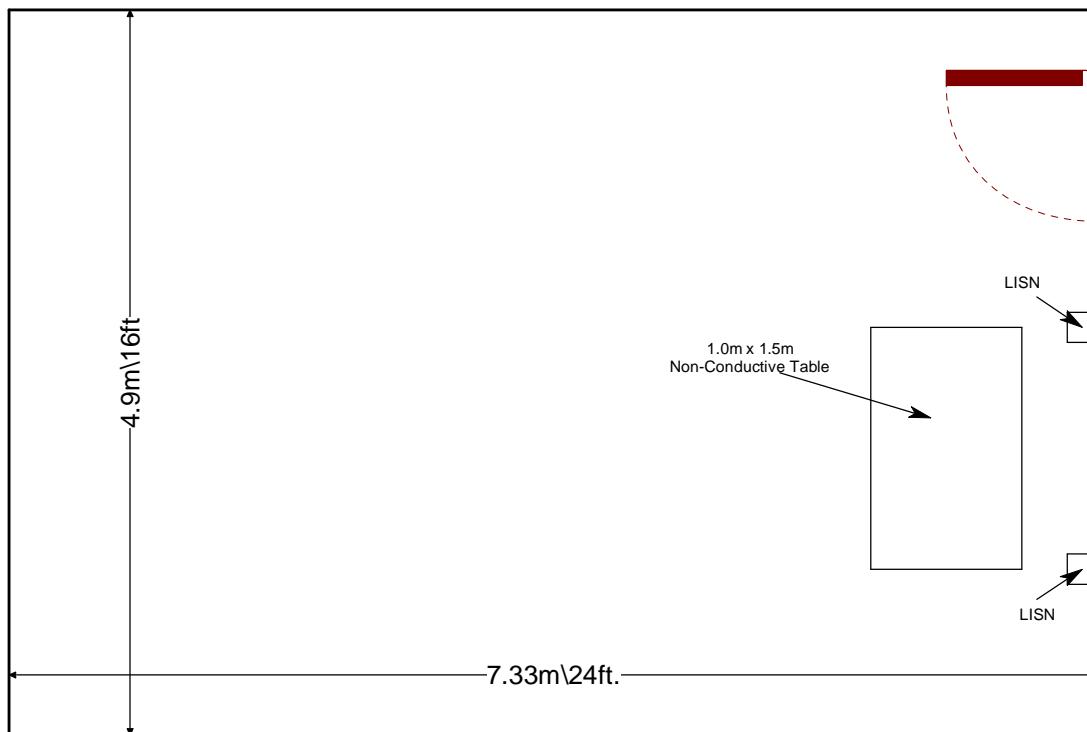


Figure 2.3.2-1: AC Mains Conducted EMI Site

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, 2017.
- ❖ US Code of Federal Regulations (CFR): Title 47, Part 15, Subpart C: Radio Frequency Devices, Intentional Radiators, 2017
- ❖ FCC KDB 558074 D01 DTS Meas Guidance v04 - Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under 15.247, April 5, 2017.
- ❖ Innovation, Science and Economic Development 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.
- ❖ Innovation, Science and Economic Development 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 List

AssetID	Manufacturer	Model #	Equipment Type	Serial #	Last Calibration Date	Calibration Due Date
78	EMCO	6502	Antennas	9104-2608	5/11/2016	5/11/2018
283	Rohde & Schwarz	FSP40	Spectrum Analyzers	1000033	7/21/2016	7/21/2018
523	Agilent	E7405	Spectrum Analyzers	MY45103293	12/9/2016	12/9/2018
2002	EMCO	3108	Antennas	2147	11/19/2015	11/19/2017
2004	EMCO	3146	Antennas	1385	11/19/2015	11/19/2017
2006	EMCO	3115	Antennas	2573	4/14/2015	4/14/2017
2011	Hewlett-Packard	HP 8447D	Amplifiers	2443A03952	11/2/2016	11/2/2017
2069	Trilithic, Inc.	7NM867/122-X1-AA	Notch Filter	200315126	3/25/2016	3/25/2017
2071	Trilithic, Inc.	4HC1400-1-KK	Filter	9643263	11/1/2016	11/1/2017
2089	Agilent Technologies, Inc.	83017A	Amplifiers	3123A00214	12/2/2016	12/2/2017
2095	ETS Lindgren	TILE4! - Version 4.2.A	Software	85242	NCR	NCR
2102	Test Equity	115	Environmental Chamber	150892	3/9/2016	3/9/2017
2111	Aeroflex Inmet	40AH2W-20	Attenuator	2111	7/20/2016	7/20/2017
2112	Teledyne Storm Products	921-0101-036	Cables	12-06-698	11/2/2016	11/2/2017
2121	ACS Boca	Radiated Cable Set	Cable Set	2121	8/1/2016	8/1/2017

Note: NCR=No Calibration Required

5 SUPPORT EQUIPMENT

Table 5-1: EUT and Support Equipment Description

Item #	Type Device	Manufacturer	Model/Part #	Serial #
1	EUT	JL Marine Systems, Inc	PUMP-CM2-8-BLS	N/A
2	DC Power Supply	BK Precision	1692 DC Power Supply	S940035931

Table 5-2: Cable Description

Cable #	Cable Type	Length	Shield	Termination
A	Power	2.36 m	No	EUT to DC Power Supply
B	Power Cable	1.84 m	No	Power Supply to AC Mains

6 EQUIPMENT UNDER TEST SETUP BLOCK DIAGRAM

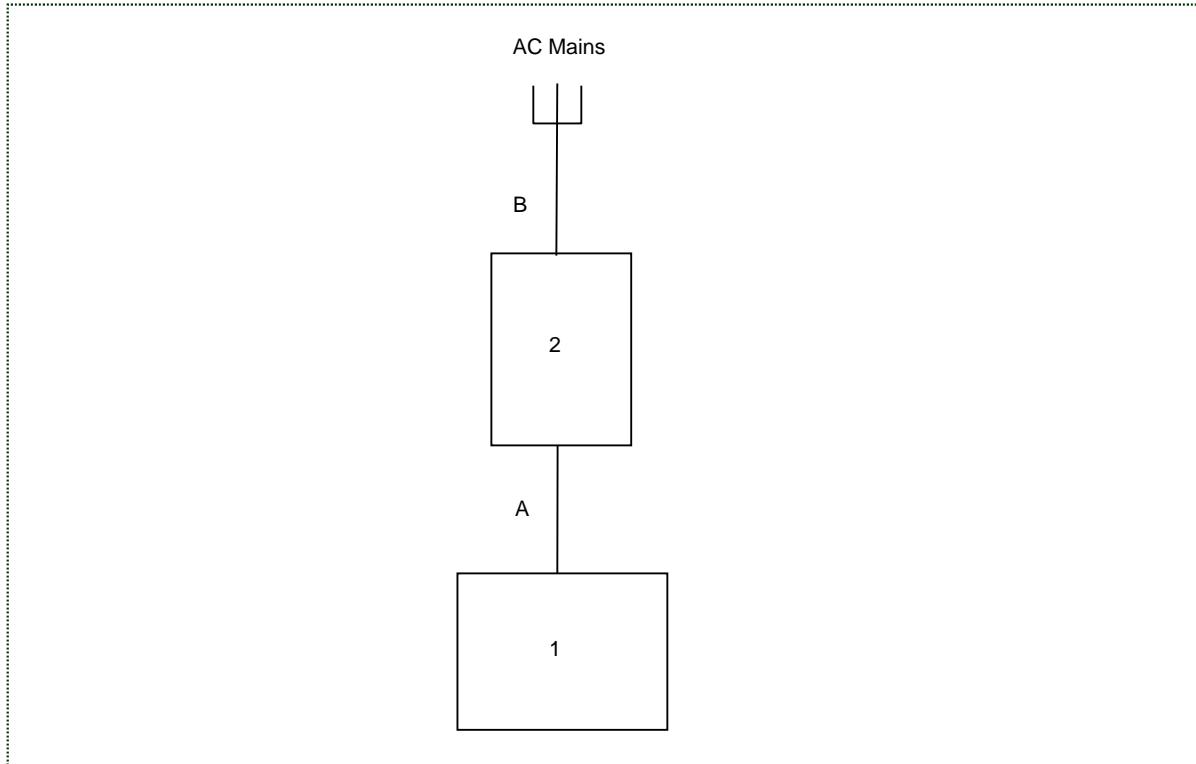


Figure 6-1: EUT Test Setup

7 SUMMARY OF TESTS

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

Table 7-1: Result Summary

Requirements	FCC Rule Part	ISED Canada	Test Results
Antenna Requirement	FCC: Section 15.203		Pass
6 dB Bandwidth	FCC: Section 15.247(a)(2)	ISED Canada: RSS-247 5.2(a)	Pass
99% Bandwidth		ISED Canada: RSS-GEN 6.6	Pass
Peak Output Power	FCC: Section 15.247(b)(3)	ISED Canada: RSS-247 5.4(d)	Pass
Band-Edge Compliance of RF Conducted Emissions	FCC: Section 15.247(d)	ISED Canada: RSS-247 5.5	Pass
RF Conducted Spurious Emissions	FCC: Section 15.247(d)	ISED Canada: RSS-247 5.5	Pass
Radiated Spurious Emissions into Restricted Frequency Bands	FCC: Sections 15.205, 15.209	ISED Canada: RSS-Gen 8.9, 8.10	Pass
Power Spectral Density	FCC: Section 15.247(e)	ISED Canada: RSS-247 5.2(b)	Pass
Power Line Conducted Emissions	FCC: Section 15.207	ISED Canada: RSS-Gen 8.8	N/A

7.1 Antenna Requirement – FCC: Section 15.203

The EUT uses a 0.8 dBi integral PCB Antenna. The antenna is not detachable thus meeting the requirements of FCC Section 15.203.

7.2 6 dB Bandwidth - FCC: Section 15.247(a)(2); ISED Canada: RSS-247 5.2(1); 99% Bandwidth ISED Canada: RSS-GEN 6.6

7.2.1 Measurement Procedure

The 6dB bandwidth was measured in accordance with the FCC KDB 558074 D01 DTS Meas Guidance v04 Section 8.2 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.

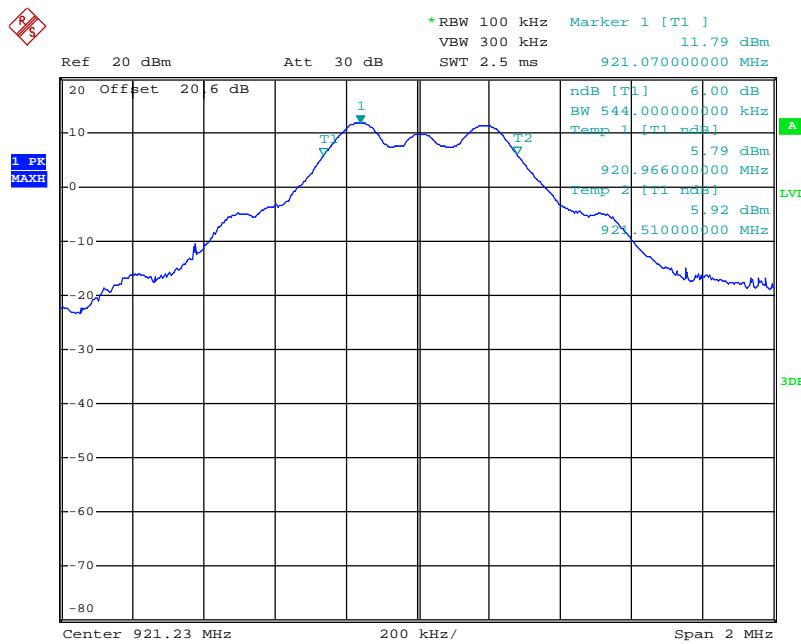
The 99% occupied bandwidth was measured with the spectrum analyzer span set to fully display the emission. The RBW was set to 1% to 5% of the approximated bandwidth. The occupied 99% bandwidth was measured by using 99% bandwidth equipment function of the spectrum analyzer.

7.2.2 Measurement Results

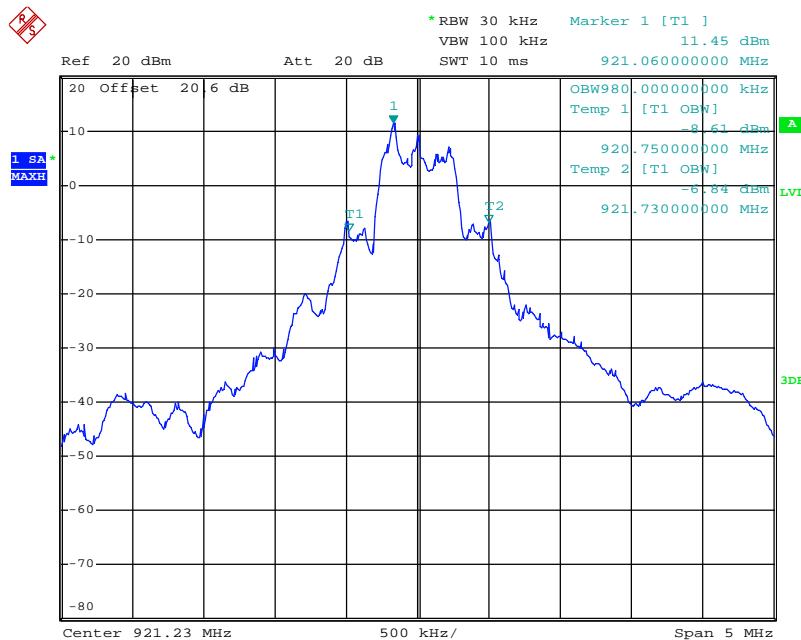
Results are shown below.

Table 7.2.2-1: 6dB / 99% Bandwidth

Frequency [MHz]	6dB Bandwidth [kHz]	99% Bandwidth [kHz]
921.23	544.00	980.00
922.73	540.00	990.00

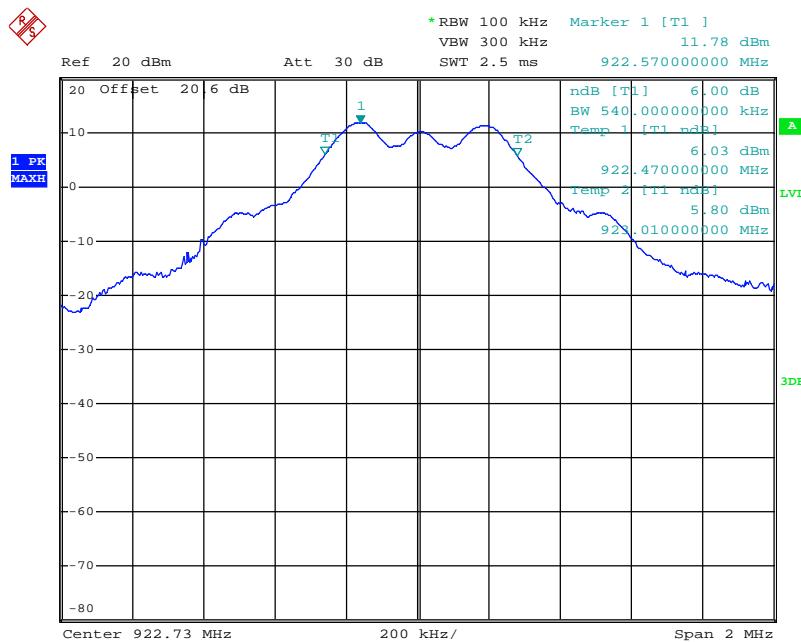


Date: 16.JAN.2017 17:02:26

Figure 7.2.2-1: 6dB BW – Low Channel

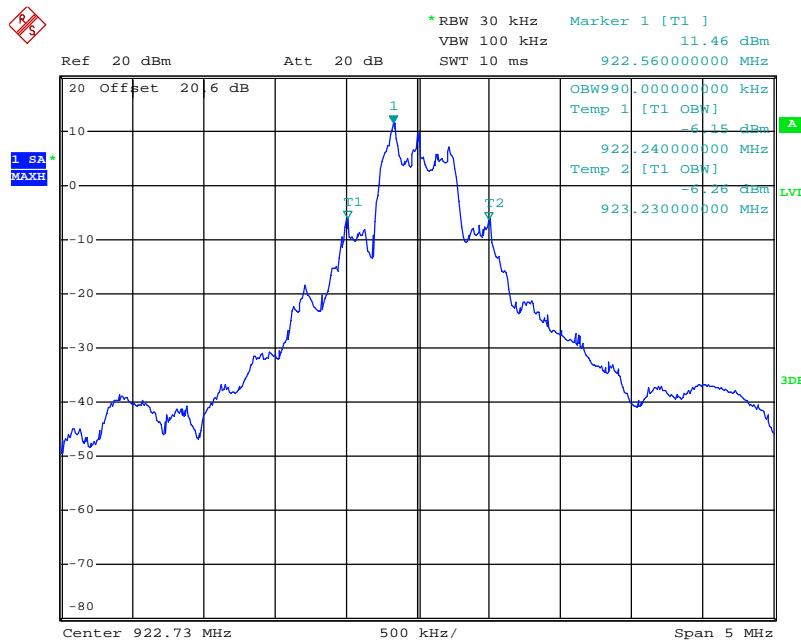
Date: 16.JAN.2017 17:19:18

Figure 7.2.2-2: 99% OBW – Low Channel



Date: 16.JAN.2017 17:36:04

Figure 7.2.2-3: 6dB BW – High Channel



Date: 16.JAN.2017 17:21:59

Figure 7.2.2-4: 99% OBW – High Channel

7.3 Peak Output Power - FCC Section 15.247(b)(3); ISED Canada: RSS-247 5.4(4)

7.3.1 Measurement Procedure (Conducted Method)

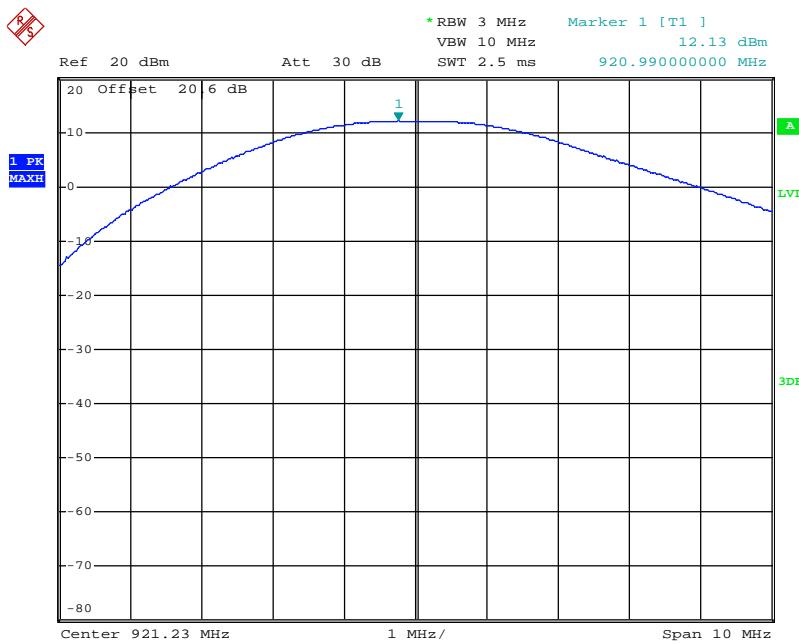
The fundamental emission output power was measured in accordance with the FCC KDB 558074 D01 DTS Meas Guidance v04 Section 9.1.1 RBW \geq DTS bandwidth. The RF output of the equipment under test was directly connected to the input of the spectrum analyzer through suitable attenuation.

7.3.2 Measurement Results

Results are shown below.

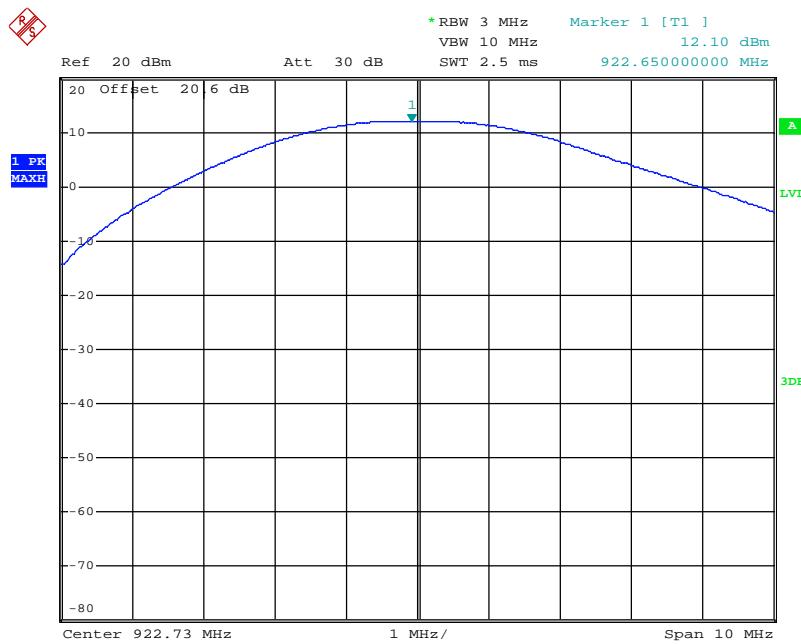
Table 7.3.2-1: RF Output Power

Frequency [MHz]	Level [dBm]
921.23	12.13
922.73	12.10



Date: 16.JAN.2017 17:17:02

Figure 7.3.2-1: RF Output Power – Low Channel



Date: 16.JAN.2017 17:27:58

Figure 7.3.2-2: RF Output Power – High Channel

7.4 Band-Edge and Spurious Emissions

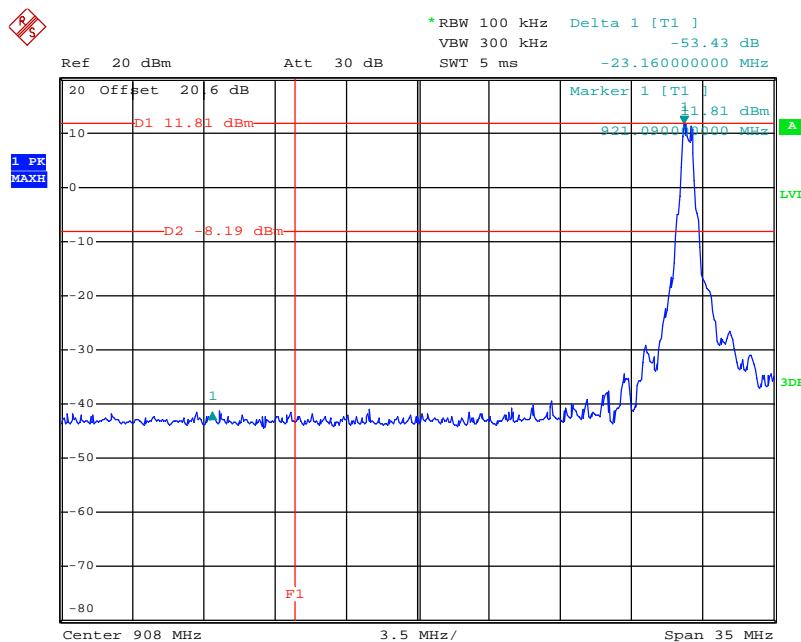
7.4.1 Band-Edge Compliance of RF Conducted Emissions - FCC Section 15.247(d); ISED Canada: RSS-247 5.5

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 transmit channel 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.

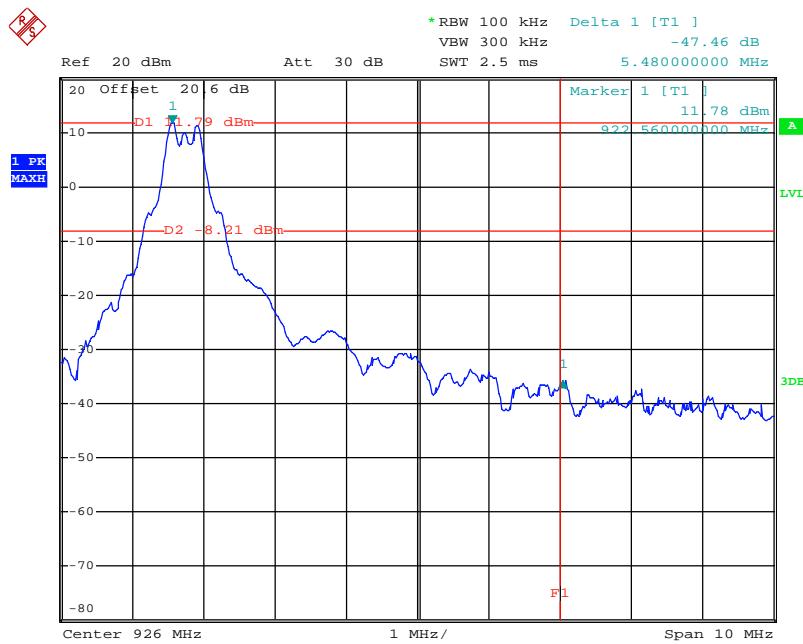
7.4.1.2 Measurement Results

Results are shown below.



Date: 16.JAN.2017 18:15:14

Figure 7.4.1.2-1: Lower Band-edge



Date: 16.JAN.2017 17:46:42

Figure 7.4.1.2-2: Upper Band-edge

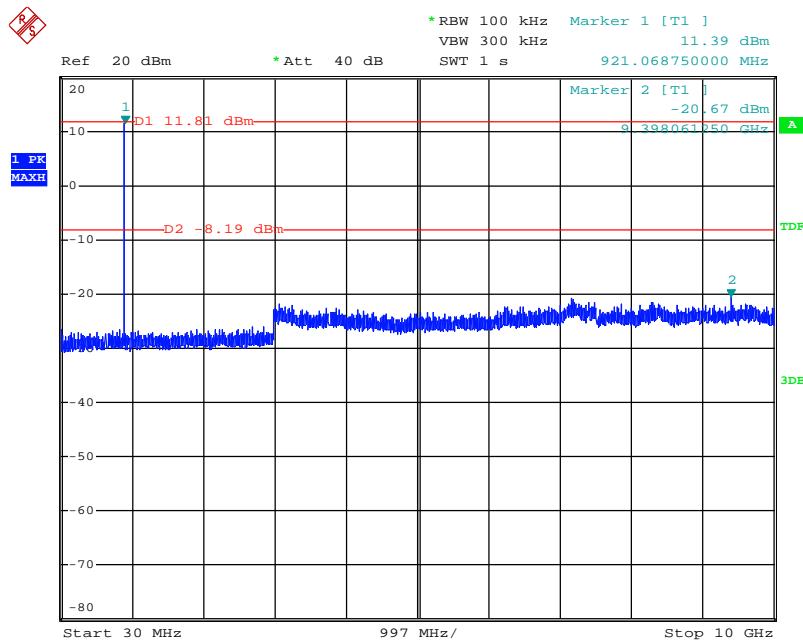
7.4.2 RF Conducted Spurious Emissions - FCC Section 15.247(d); ISED Canada: RSS-247 5.5

7.4.2.1 Measurement Procedure

The RF Conducted Spurious Emissions were measured in accordance with the FCC KDB 558074 D01 DTS Meas Guidance v04 Section 11.3 Emission level measurement. 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 30MHz to 10 GHz, 10 times the highest fundamental frequency. 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.

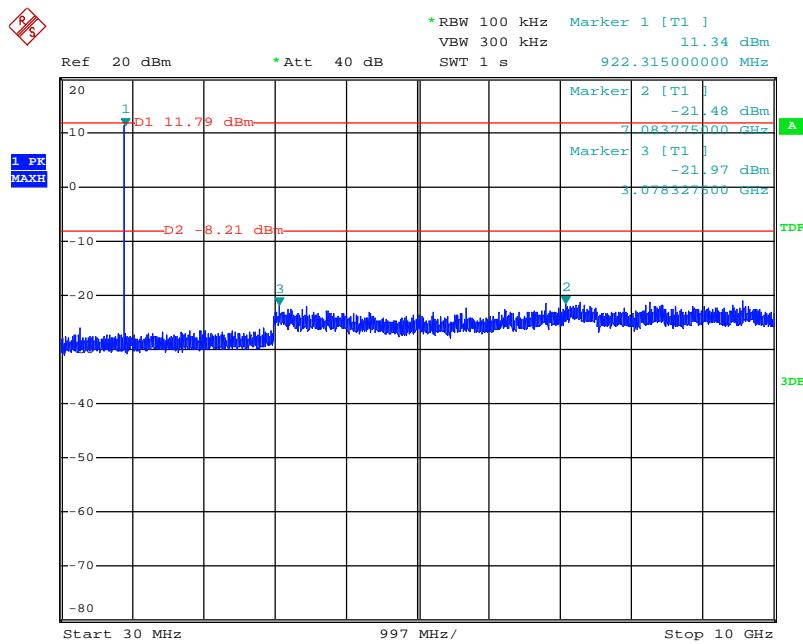
7.4.2.2 Measurement Results

Results are shown below.



Date: 16.JAN.2017 18:19:34

Figure 7.4.2.2-1: 30 MHz – 10 GHz – Low Channel



Date: 16.JAN.2017 18:24:14

Figure 7.4.2.2-2: 30 MHz – 10 GHz – High Channel

7.4.3 Radiated Spurious Emissions into Restricted Frequency Bands – FCC Sections 15.205, 15.209; ISED Canada: 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 10 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.

7.4.3.2 Measurement Results

Radiated band-edge and spurious emissions found in the restricted frequency bands of 9 kHz to 10 GHz are reported in the tables below.

Table 7.4.3.2-1: Radiated Spurious Emissions Tabulated Data

Frequency (MHz)	Level (dBuV)		Antenna Polarity (H/V)	Correction Factors (dB)	Corrected Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
	pk	Qpk/Avg			pk	Qpk/Avg	pk	Qpk/Avg	pk	Qpk/Avg
Low Channel = 921.23 MHz										
2763.69	56.67	53.69	H	-3.24	53.43	50.45	74.0	54.0	20.6	3.6
2763.69	56.11	53.42	V	-3.24	52.87	50.18	74.0	54.0	21.1	3.8
3684.92	50.42	46.00	H	0.35	50.77	46.35	74.0	54.0	23.2	7.6
3684.92	48.69	43.33	V	0.35	49.04	43.68	74.0	54.0	25.0	10.3
4606.15	46.31	40.51	H	2.59	48.90	43.10	74.0	54.0	25.1	10.9
4606.15	47.85	43.29	V	2.59	50.44	45.88	74.0	54.0	23.6	8.1
7369.84	44.62	35.35	H	9.24	53.86	44.59	74.0	54.0	20.1	9.4
7369.84	45.47	37.28	V	9.24	54.71	46.52	74.0	54.0	19.3	7.5
8291.07	42.96	32.02	V	10.25	53.21	42.27	74.0	54.0	20.8	11.7

Notes:

All emissions above 8.3 GHz were attenuated below the limits and the noise floor of the measurement equipment.

Table 7.4.3.2-2: Radiated Spurious Emissions Tabulated Data

Frequency (MHz)	Level (dBuV)		Antenna Polarity (H/V)	Correction Factors (dB)	Corrected Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
	pk	Qpk/Avg			pk	Qpk/Avg	pk	Qpk/Avg	pk	Qpk/Avg
High Channel = 922.73 MHz										
2768.19	56.28	53.59	H	-3.22	53.06	50.37	74.0	54.0	20.9	3.6
2768.19	55.83	53.00	V	-3.22	52.61	49.78	74.0	54.0	21.4	4.2
3690.92	50.34	46.38	H	0.38	50.72	46.76	74.0	54.0	23.3	7.2
3690.92	49.66	45.16	V	0.38	50.04	45.54	74.0	54.0	24.0	8.5
4613.65	46.18	40.44	H	2.62	48.80	43.06	74.0	54.0	25.2	10.9
4613.65	48.47	43.76	V	2.62	51.09	46.38	74.0	54.0	22.9	7.6
7381.84	44.83	35.40	H	9.25	54.08	44.65	74.0	54.0	19.9	9.3
7381.84	45.51	37.71	V	9.25	54.76	46.96	74.0	54.0	19.2	7.0
8304.57	42.87	32.14	V	10.28	53.15	42.42	74.0	54.0	20.8	11.6

Notes:

All emissions above 8.3 GHz were attenuated below the limits and the noise floor of the measurement equipment.

7.4.3.3 Sample Calculations

$$R_c = R_u + CF_T$$

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: $56.67 + (-3.24) = 53.43 \text{ dB}\mu\text{V/m}$

Margin: $74 \text{ dB}\mu\text{V/m} - 53.43 \text{ dB}\mu\text{V/m} = 20.57 \text{ dB}$

Example Calculation: Average

Corrected Level: $53.69 + (-3.24) = 50.45 \text{ dB}\mu\text{V/m}$

Margin: $54 \text{ dB}\mu\text{V/m} - 50.45 \text{ dB}\mu\text{V/m} = 3.55 \text{ dB}$

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

7.5.1 PSD Measurement Procedure (Conducted Method)

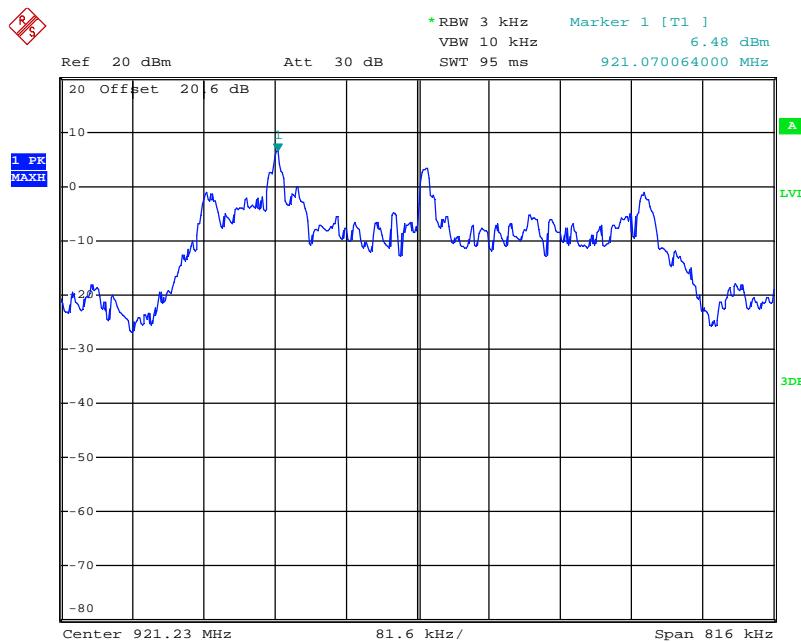
The power spectral density was measured in accordance with the FCC KDB 558074 D01 DTS Meas Guidance v04 Section 10.2 Method PKPSD (peak PSD). The RF output port of the EUT was directly connected to the input of the spectrum analyzer. Offset values were input for cable and external attenuation. The spectrum 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.

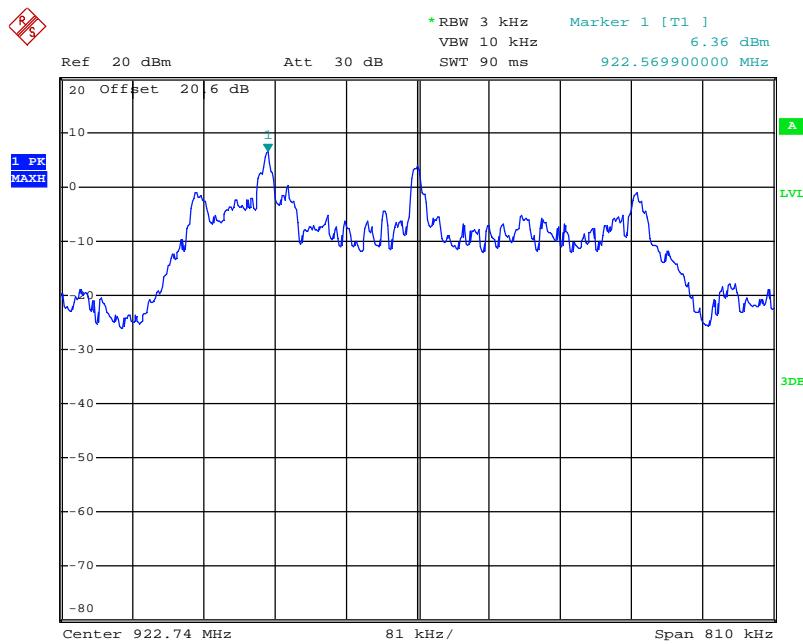
Table 7.5.2-1: Power Spectral Density

Frequency [MHz]	PSD [dBm]	Limit [dBm]	Margin [dB]
921.23	6.48	8.0	1.52
922.73	6.36	8.0	1.64



Date: 16.JAN.2017 17:13:42

Figure 7.5.2-1: Power Spectral Density – Low Channel



Date: 16.JAN.2017 17:42:04

Figure 7.5.2-2: Power Spectral Density – High Channel

8 MEASUREMENT UNCERTAINTIES

The expanded laboratory measurement uncertainty figures (U_{Lab}) provided below correspond to an expansion factor (coverage factor) $k = 1.96$ which provide confidence levels of 95%.

Table 8-1: Measurement Uncertainties

Parameter	U_{Lab}
Occupied Channel Bandwidth	$\pm 0.009 \%$
RF Conducted Output Power	$\pm 1.15 \text{ dB}$
Power Spectral Density	$\pm 1.15 \text{ dB}$
Antenna Port Conducted Emissions	$\pm 1.15 \text{ dB}$
Radiated Emissions $\leq 1\text{GHz}$	$\pm 5.86 \text{ dB}$
Radiated Emissions $> 1\text{GHz}$	$\pm 4.65 \text{ dB}$
Temperature	$\pm 0.860 \text{ }^{\circ}\text{C}$
Radio Frequency	$\pm 2.832 \times 10^{-8}$
AC Power Line Conducted Emissions	$\pm 3.72 \text{ dB}$

9 CONCLUSION

In the opinion of TÜV SÜD America, Inc., the Model PUMP-CM2-8-BLS manufactured by JL MARINE SYSTEMS, INC. meets the requirements of FCC Part 15 subpart C and Innovation, Science and Economic Development Canada's Radio Standards Specification RSS-247 for the test procedures documented in the test report.

END REPORT