Certification Test Report

FCC ID: MTFWMS-0001
IC: 2175D-WMS0001

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

Report Number: AT72143104-1C1

Manufacturer: Telular, Corp.
Model: WMS-0001

Test Begin Date: October 22, 2018
Test End Date: October 24, 2018

Report Issue Date: November 29, 2018

FOR THE SCOPE OF ACCREDITATION UNDER Certificate Number: 2955.09

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

Prepared By:

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Reviewed by:

Ryan McGann
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This report contains 20 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 Certification for modular approval.

1.2 Product Description

The Telular WMS-0001 is a battery-powered wireless sensor device operating in the ISM 915 MHz band using a proprietary wireless protocol. It senses acceleration, temperature, humidity, and door state and transmits data wirelessly to other products.

Technical Information:

Detail	Description
Frequency Range	905 – 924 MHz
Number of Channels	20
Modulation Format	GFSK
Data Rates	500kbps
Operating Voltage	7.2Vdc Battery
Antenna Type / Gain	PCB Trace / 0dBi

Manufacturer Information:
Telular Corp.
3225 Cumberland Blvd SE, Suite 300
Atlanta, GA 30339

Test Sample Serial Number: Radiated Emissions: "FCC"
RF Conducted Emissions: C02WDVG

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.

For radiated emissions, the EUT was evaluated in three orthogonal orientations. The worst-case orientation was Y-position. The EUT was programmed to generate a continuously modulated signal on each channel evaluated.

For RF Conducted measurements, the EUT was connected to the test equipment with a U.FL to SMA connector. The EUT was programmed to generate a continuously modulated signal on each channel evaluated.

Software power setting during test: 200 (20dBm)

2 TEST FACILITIES

2.1 Location

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

TÜV SÜD America, Inc.
5945 Cabot Pkwy, Suite 100
Alpharetta, GA 30005
Phone: (678) 341-5900

2.2 Laboratory Accreditations/Recognitions/Certifications

TÜV SÜD America, Inc. is accredited to ISO/IEC 17025 by the American Association for Laboratory Accreditation/A2LA accreditation program and has been issued certificate number 2955.09 in recognition of this accreditation.

Unless otherwise specified, all tests methods described within this report are covered under the ISO/IEC 17025 scopes of accreditation.

The Semi-Anechoic Chamber Test Sites and Conducted Emissions Sites have been fully described, submitted to, and accepted by the FCC, ISED Canada and the Japanese Voluntary Control Council for Interference by information technology equipment.

FCC Registration Number:	967699
ISED Canada Lab Code:	23932
VCCI Member Number:	1831
• VCCI Registration Number	A-0295

2.3 Radiated Emissions Test Site Description

2.3.1 Semi-Anechoic Chamber Test Site

The Semi-Anechoic Chamber Test Site consists of a 20'W x 30'L x 20'H shielded enclosure. The chamber is lined with ETS-Lindgren Ferrite Absorber, model number FT-1500. The ferrite tile 600 mm x 600 mm (2.62 in x 23.62 in) panels and are mounted directly on the inner walls of the chamber shield.

The specular regions of the chamber are lined with additional ETS-Lindgren PS-600 hybrid absorber to extend its frequency range up to 18GHz and beyond.

The turntable is a 2m ETS-Lindgren Model 2170, and installed off the center axis is located 5'6" 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 shield using #8 solid copper wire.

The antenna mast is an EMCO 1060 and is remotely controlled from the control room for both antenna height and polarization.

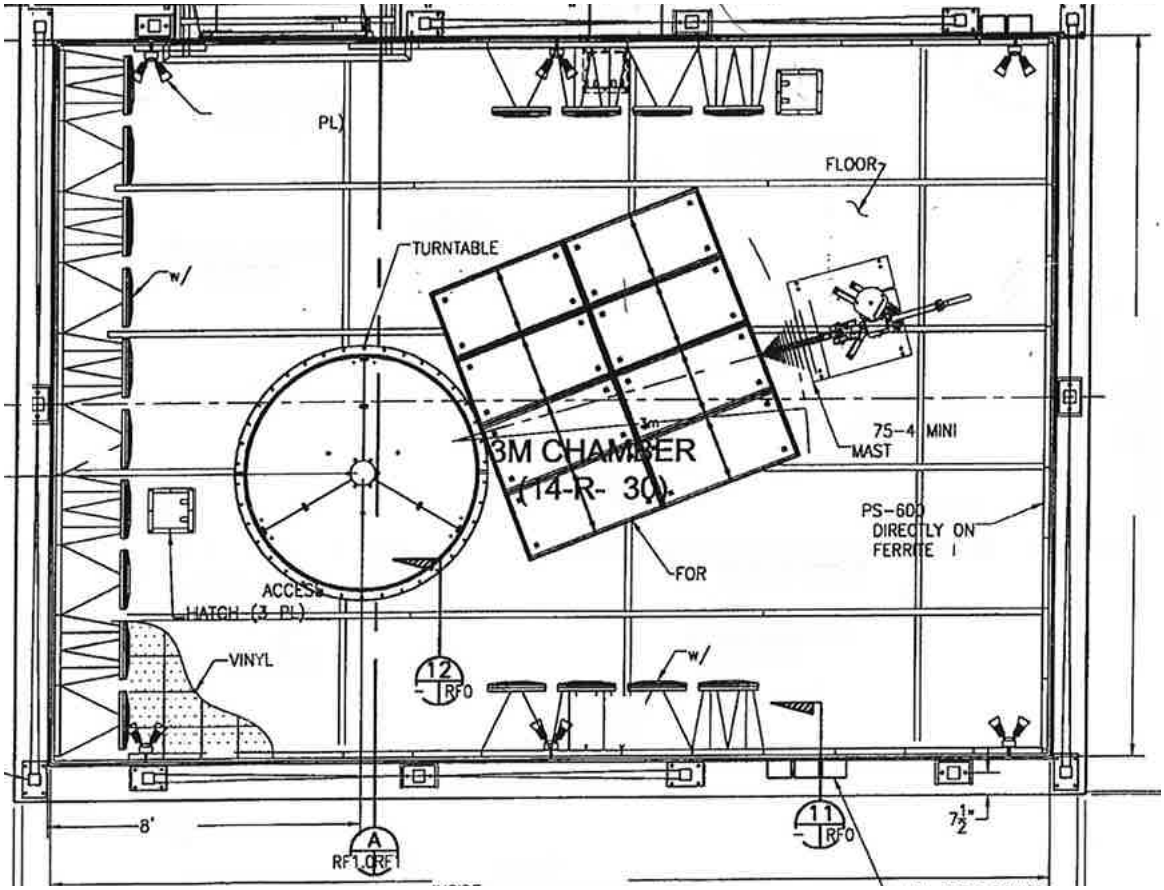

Figure 2.3.1-1: Semi-Anechoic Chamber Test Site

2.4 Conducted Emissions Test Site Description

2.4.1 Conducted Emissions Test Site

The AC mains conducted EMI site is located in the main EMC lab. It consists of a 12' x 10' horizontal coupling plane(HCP) as well as a 12'x8' vertical coupling plane(VCP). The HGP is constructed of 4' x 10' sheets of particle board sandwiched by galvanized steel sheets. These panels are bonded using 11AWG 1/8" x 2" by 10' galvanized sheet steel secured to the panels via by screws. The VCP is constructed of three 4'x8' sheets of 11AWG solid aluminum.

The HCP and VCP are electrically bonded together using 1"x1" angled aluminum secured with screws.

The site is of sufficient size to test table top and floor standing equipment in accordance with ANSI C63.10.

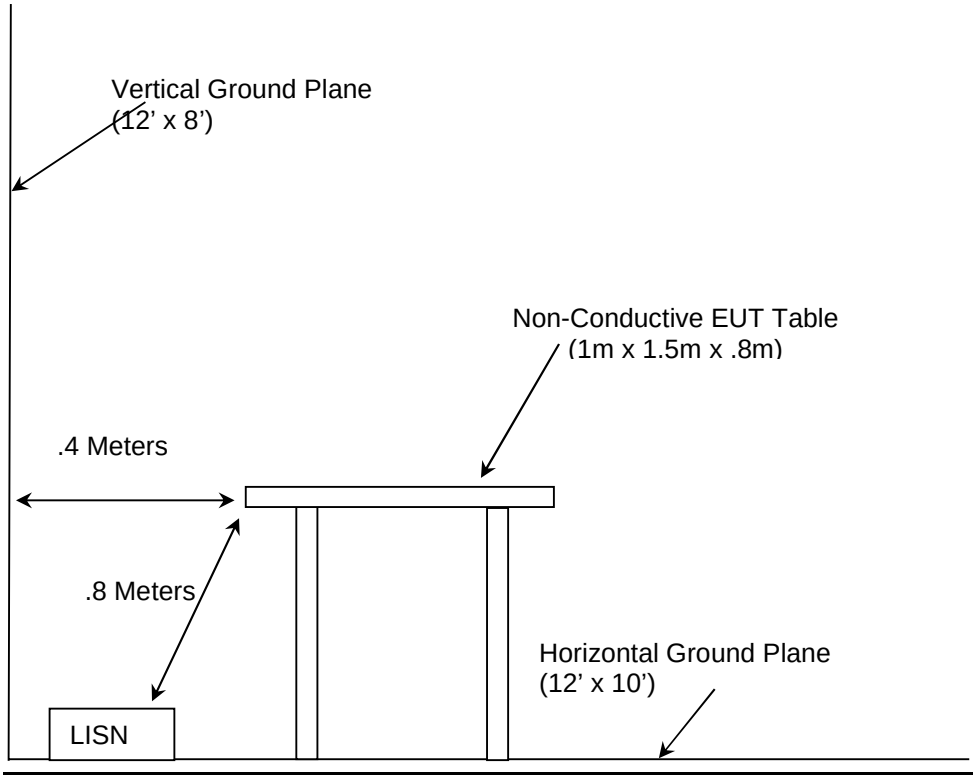

Figure 2.4.1-1: AC Mains Conducted EMI Site

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 2, Subpart J: Equipment Authorization Procedures, 2018
- US Code of Federal Regulations (CFR): Title 47, Part 15, Subpart C: Radio Frequency Devices, Intentional Radiators, 2018
- FCC KDB 558074 D01 DTS Meas Guidance v05 - Guidance for Compliance Measurements on Digital Transmission System, Frequency Hopping Spread Spectrum System, and Hybrid System Devices Operating Under Section15.247 of the FCC Rules, August 24, 2018
- ISED Canada Radio Standards Specification: RSS-247 – Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices, Issue 2, February 2017.
- 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 Number	Last Calibration Date	Calibration Due Date
30	Spectrum Technologies	DRH-0118	1-18GHz Horn Antenna	970102	05/09/2017	05/09/2019
90	Electro-metrics	LPA25	LPA Antenna	1476	01/03/2018	01/03/2020
213	TEC	PA 102	Amplifier	44927	7/19/2018	7/19/2019
337	Microwave Circuits	H1G513G1	Microwave Bandpass Filter	282706	05/16/2018	05/16/2019
338	Hewlett Packard	8449B	High Frequency Pre-Amp	3008A01111	07/11/2017	07/11/2019
622	Rohde & Schwarz	FSV40 (v3.40)	FSV Signal Analyzer 10Hz to 40GHz	101338	07/30/2018	07/30/2020
628	EMCO	6502	Active Loop Antenna 10kHz-30MHz	9407-2877	02/11/2016	02/11/2019
731	EMCO	3104	Bicon Antenna	2659	11/09/2016	11/09/2018
819	Rohde & Schwarz	ESR26	EMI Test Receiver	101345	10/31/2017	10/31/2018
827	(-)	TS8997 Rack Cable Set	TS8997 Rack Cable Set	N/A	08/13/2018	08/13/2019
836	ETS Lindgren	SAC Cable Set	SAC Cable Set includes 620, 837, 838	N/A	05/01/2018	05/01/2019

5 SUPPORT EQUIPMENT

Table 5-1: Support Equipment

Item	Equipment Type	Manufacturer	Model/Part Number	Serial Number
1	Spectrum Analyzer	Rohde & Schwarz	FSV40	101338
2	Desktop PC	Lenovo	ThinkCentre M170t	MJ07AD0C
3	Interface Board	NA	NA	NA
4	Communications Board	NA	NA	NA

Table 5-2: Cable Description

Cable	Cable Type	Length	Shield	Termination
A	Ribbon Cable	0.12m	No	Interface Board to Comm Board
B	USB-Serial	1.5m	Yes	Comm Board to PC

6 EQUIPMENT UNDER TEST SETUP BLOCK DIAGRAM

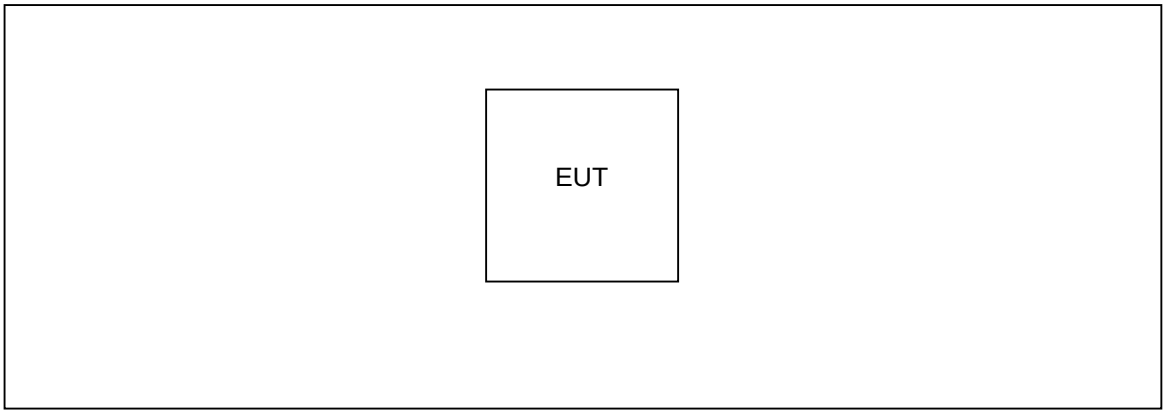

Figure 6-1: Test Setup Block Diagram – Radiated Emissions

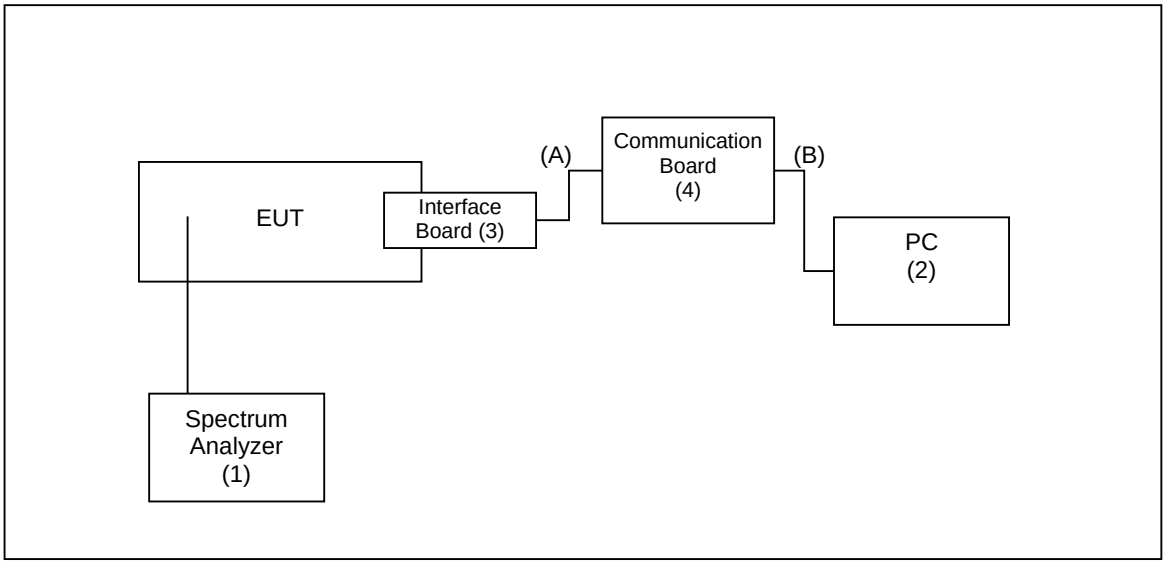

Figure 6-2: Test Setup Block Diagram – Antenna Port Conducted Emissions

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 a PCB trace antenna. The antenna is integral to the device and cannot be removed or replaced by the end user. The gain of the antenna is 0 dBi.

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

7.2.1 Measurement Procedure

AC power line conducted emissions was not applicable. The device is battery powered with no facility to connect to the AC mains.

7.3 6dB / 99% Bandwidth – FCC: Section 15.247(a)(2); ISED Canada: RSS-247 5.2(a)

7.3.1 Measurement Procedure

The RF output port of the EUT was directly connected to the input of the spectrum analyzer using suitable attenuation. The span of the spectrum analyzer display was set between two times and five times the occupied bandwidth (OBW) of the emission. The RBW of the spectrum analyzer was set to 100kHz. The trace was set to max hold with a peak detector active. The ndB down measurement functions of the analyzer were utilized to determine the 6 dB DTS 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 from 1% to 5% of the occupied bandwidth and the video bandwidth set to at least 3 times the resolution bandwidth. A peak detector was used.

7.3.2 Measurement Results

Performed by: Jeremy Pickens

Table 7.3.2-1: 6dB / 99% Bandwidth

Frequency [MHz]	6dB Bandwidth [kHz]	99% Bandwidth [kHz]
905	511.9	587.55
915	512.3	587.55
924	510.7	581.77

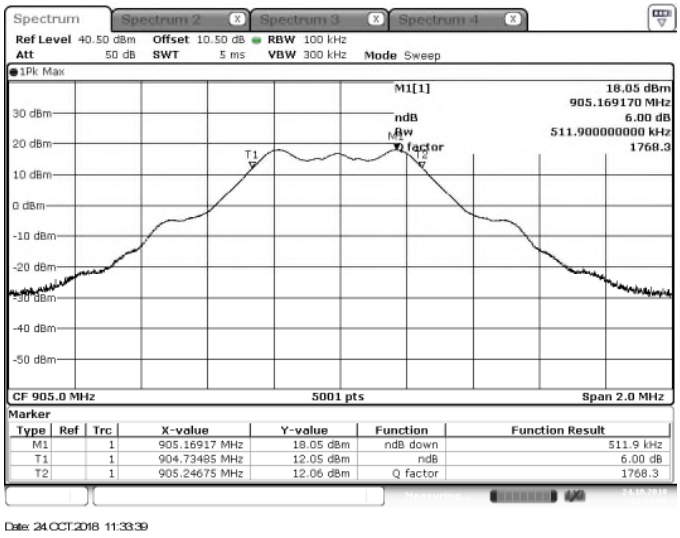

Figure 7.3.2-1: 6dB Bandwidth – LCH

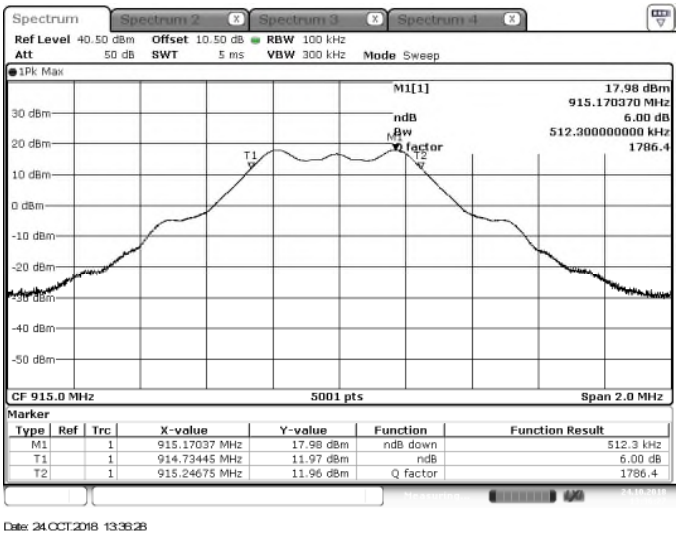

Figure 7.3.2-2: 6dB Bandwidth – MCH

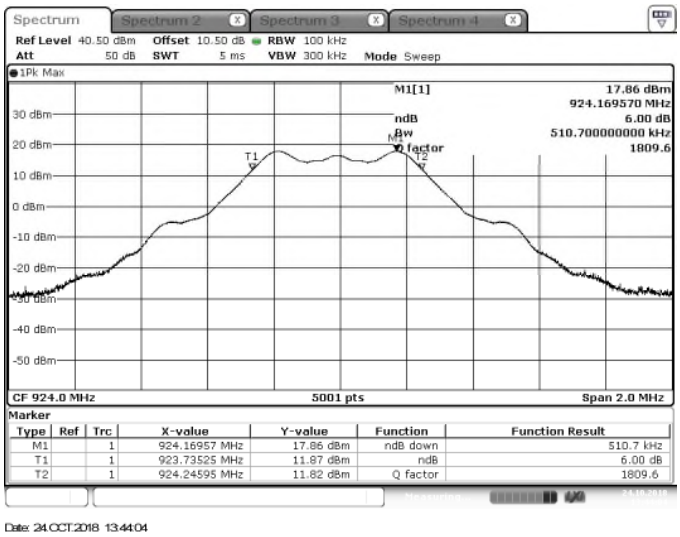

Figure 7.3.2-3: 6dB Bandwidth – HCH

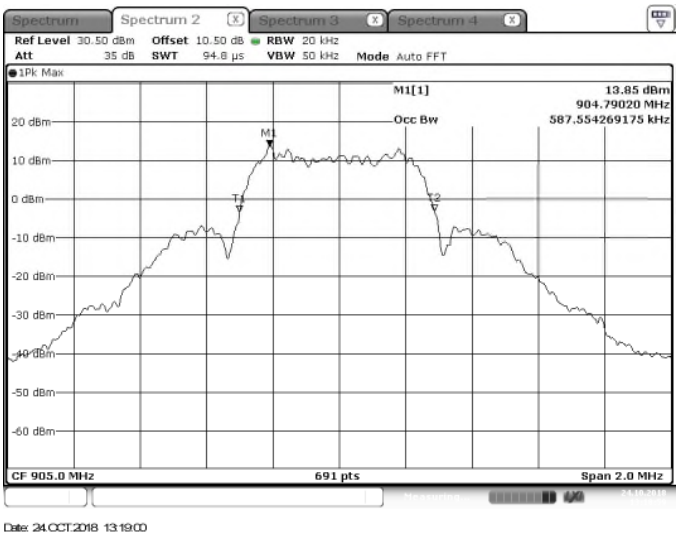

Figure 7.3.2-4: 99% Occupied Bandwidth – LCH

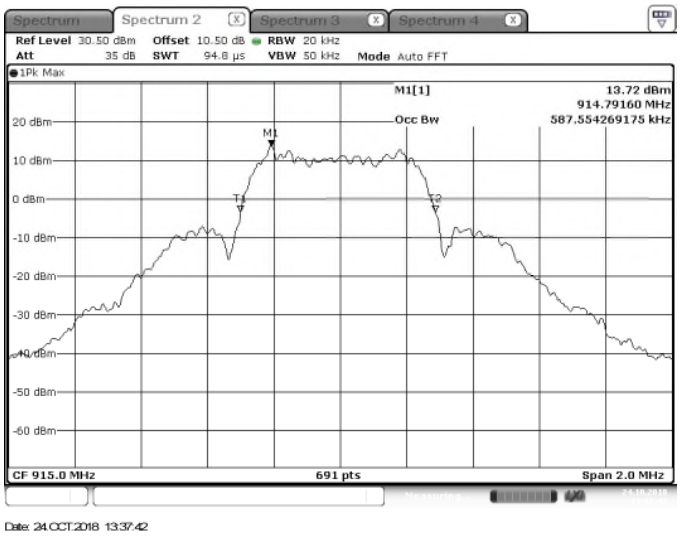

Figure 7.3.2-5: 99% Occupied Bandwidth – MCH

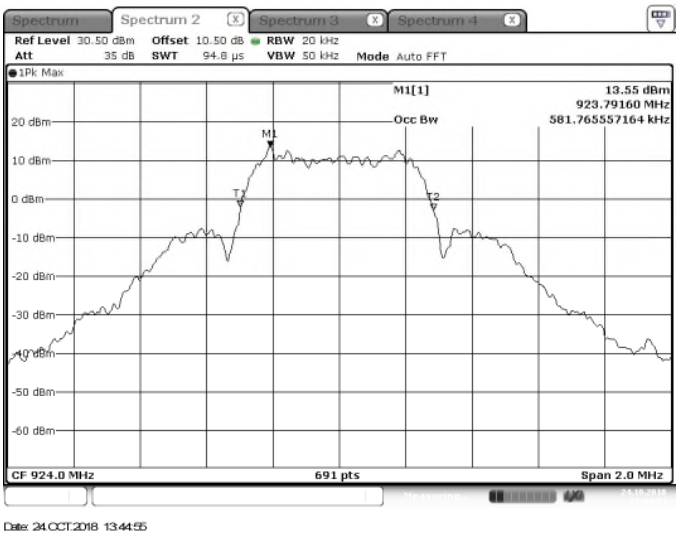

Figure 7.3.2-6: 99% Occupied Bandwidth – HCH

7.4 Fundamental Emission Output Power – FCC: Section 15.247(b)(3); ISED Canada: RSS-247 5.4(d)

7.4.1 Measurement Procedure

The maximum conducted output power was measured in accordance with FCC KDB 558074 D01 utilizing a peak power meter with a video bandwidth of 30MHz. The RF output of the equipment under test was directly connected to the input of the power meter applying suitable attenuation.

7.4.2 Measurement Results

Performed by: Jeremy Pickens

Table 7.4.2-1: Maximum Conducted Output Power (Peak)

Frequency [MHz]	Level [dBm]
905	18.21
915	17.96
924	17.86

7.5 Emission Levels

7.5.1 Emissions into Non-Restricted Frequency Bands – FCC: Section 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 ANSI C63.10, Clause 11.11.13. 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 centered on each channel evaluated. 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 30 MHz to 10 GHz, 10 times the highest fundamental frequency.

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

Performed by: Jeremy Pickens

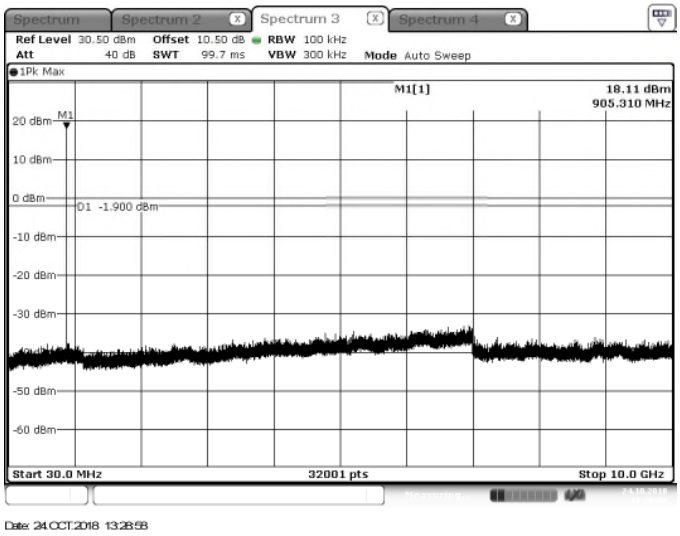

Figure 7.5.1.2-1: 30 MHz – 10 GHz – Low Channel

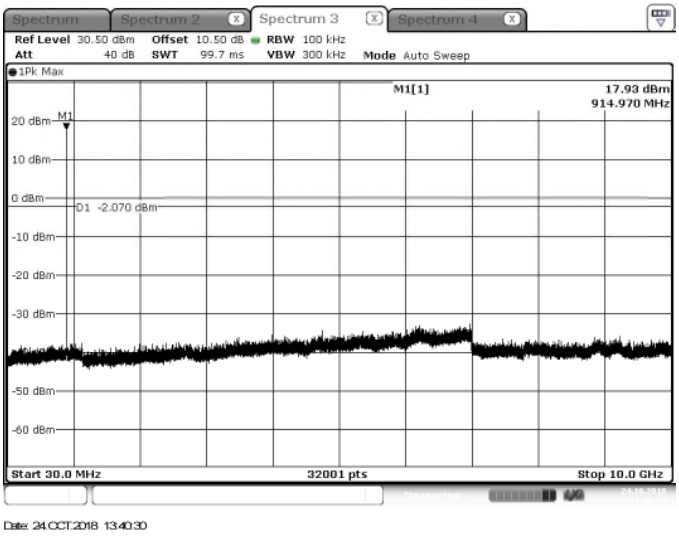

Figure 7.5.1.2-2: 30 MHz – 10 GHz – Middle Channel

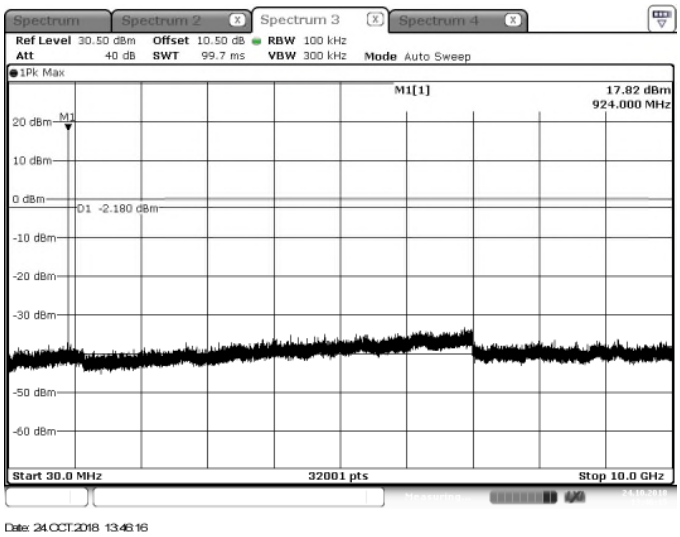

Figure 7.5.1.2-3: 30 MHz – 10 GHz –High Channel

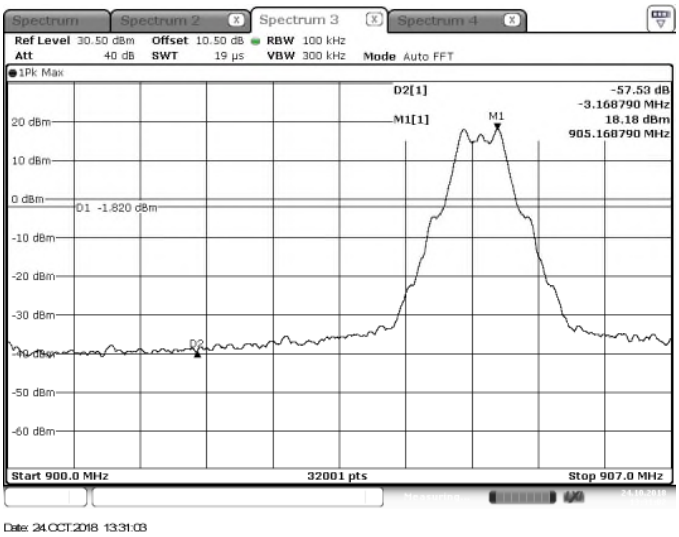

Figure 7.5.1.2-4: Lower Band-edge

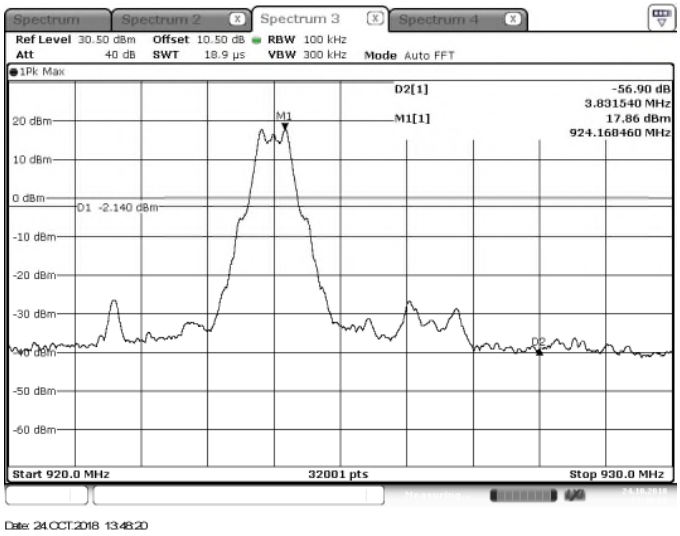

Figure 7.5.1.2-5: Upper Band-edge

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

7.5.2.1 Measurement Procedure

The unwanted emissions into restricted bands were measured radiated over the frequency range of 30 MHz to 10 GHz, 10 times the highest fundamental frequency.

The EUT was rotated through 360° and the receive antenna height was varied from 1 meter to 4 meters so that the maximum radiated emissions level would be detected. For frequencies below 1000 MHz, 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 and average measurements were made with RBW and VBW of 1 MHz and 3 MHz respectively.

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.

7.5.2.2 Measurement Results

Performed by: Tyler Leeson

Table 7.5.2.2-1: 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
Low Channel										
2715	50.10	38.80	H	0.41	50.51	39.21	74.0	54.0	23.5	14.8
2715	50.50	38.40	V	-3.06	47.44	35.34	74.0	54.0	26.6	18.7
3620	52.80	41.50	H	2.16	54.96	43.66	74.0	54.0	19.0	10.3
3620	49.90	37.30	V	0.12	50.02	37.42	74.0	54.0	24.0	16.6
4525	51.20	39.90	H	5.21	56.41	45.11	74.0	54.0	17.6	8.9
4525	51.20	40.10	V	1.75	52.95	41.85	74.0	54.0	21.0	12.1
5430	51.90	40.50	H	7.60	59.50	48.10	74.0	54.0	14.5	5.9
5430	49.80	37.50	V	4.97	54.77	42.47	74.0	54.0	19.2	11.5
Middle Channel										
2745	49.70	38.90	H	0.50	50.20	39.40	74.0	54.0	23.8	14.6
2745	50.20	39.10	V	-2.95	47.25	36.15	74.0	54.0	26.8	17.9
3660	53.90	43.70	H	2.34	56.24	46.04	74.0	54.0	17.8	8.0
3660	51.60	39.90	V	0.24	51.84	40.14	74.0	54.0	22.2	13.9
4575	50.70	39.70	H	5.30	56.00	45.00	74.0	54.0	18.0	9.0
4575	51.80	40.90	V	1.97	53.77	42.87	74.0	54.0	20.2	11.1
High Channel										
2772	49.60	37.10	H	0.58	50.18	37.68	74.0	54.0	23.8	16.3
2772	51.20	38.10	V	-2.86	48.34	35.24	74.0	54.0	25.7	18.8
3696	54.40	44.20	H	2.50	56.90	46.70	74.0	54.0	17.1	7.3
3696	54.20	43.30	V	0.35	54.55	43.65	74.0	54.0	19.4	10.3
4620	49.20	37.90	H	5.38	54.58	43.28	74.0	54.0	19.4	10.7
4620	50.60	40.10	V	2.16	52.76	42.26	74.0	54.0	21.2	11.7

7.6 Maximum Power Spectral Density – FCC: Section 15.247(e) ISED Canada: RSS-247 5.3(b)

7.6.1 Measurement Procedure

The power spectral density was measured in accordance with Clause 11.10.2 of ANSI C63.10 utilizing the PKPSD 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 detector was set to peak and auto sweep. Once the trace stabilized, the marker to peak function was used to find the highest peak PSD within the emission envelope.

7.6.2 Measurement Results

Performed by: Jeremy Pickens

Table 7.6.2-1: Power Spectral Density

Frequency [MHz]	PSD Level [dBm]
905	5.96
915	5.83
924	5.67

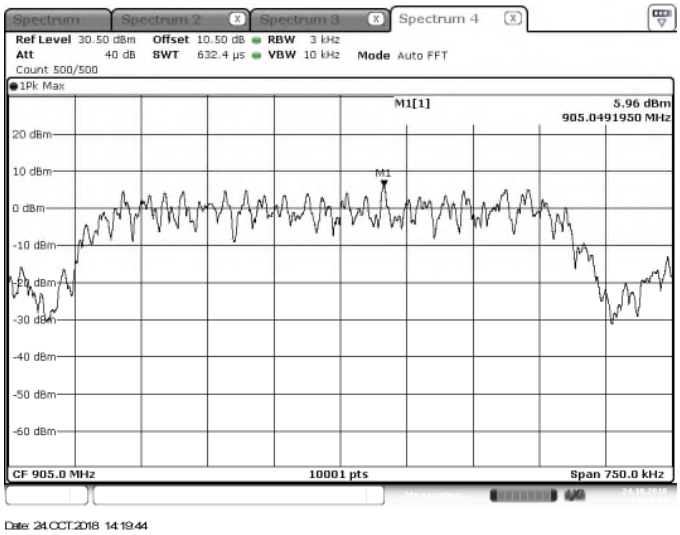

Figure 7.6.2-1: Power Spectral Density – LCH

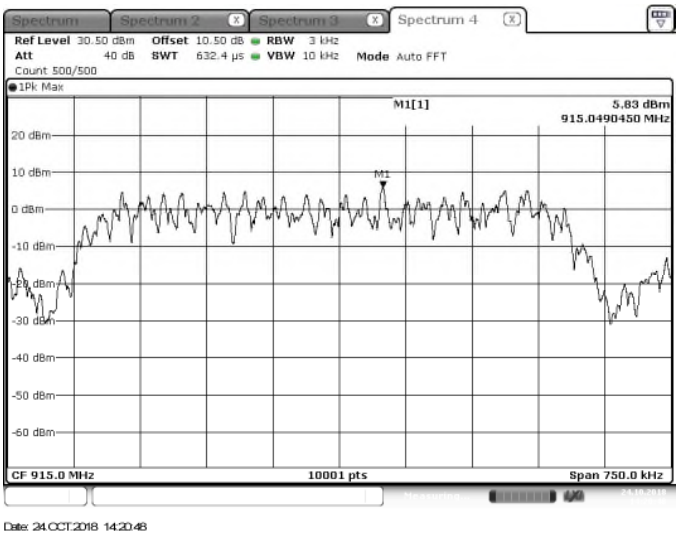

Figure 7.6.2-2: Power Spectral Density – MCH

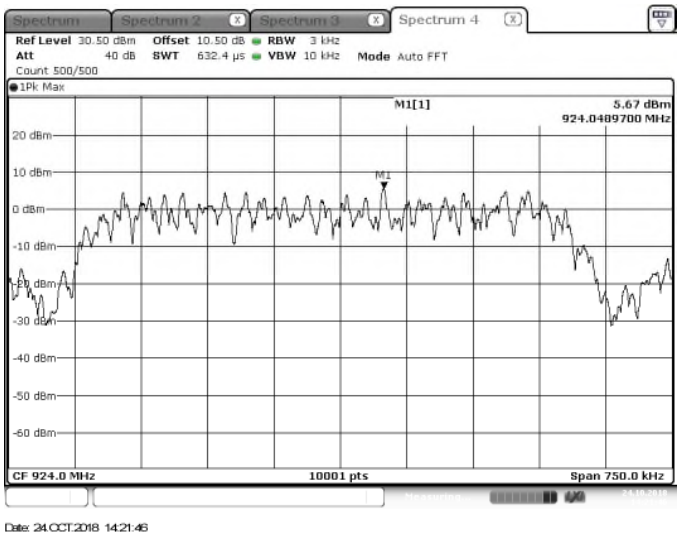

Figure 7.6.2-3: Power Spectral Density – HCH

8 ESTIMATION OF MEASUREMENT UNCERTAINTY

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%.

Parameter	U_{lab}
Occupied Channel Bandwidth	± 0.009 %
RF Conducted Output Power	± 0.349 dB
Power Spectral Density	± 0.372 dB
Antenna Port Conducted Emissions	± 1.264 dB
Radiated Emissions ≤ 1 GHz	± 5.814 dB
Radiated Emissions > 1 GHz	± 4.318 dB
Temperature	± 0.860 °C
Radio Frequency	± 2.832 x 10^{-8}
AC Power Line Conducted Emissions	± 3.360 dB

9 CONCLUSION

In the opinion of TÜV SÜD America, Inc. the WMS-0001, manufactured by Telular Corp. meets the requirements of FCC Part 15 subpart C and ISED Canada's Radio Standards Specification RSS-247 for the tests documented in this test report.

END REPORT