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Certification Test Report

FCC ID: 2AFWA-UMR-2

FCC Rule Part: 15.247

ACS Report Number: 15-3040.W03.2A

Manufacturer: ILS Technology LLC
Model: UMR-2

Test Begin Date: August 24, 2015
Test End Date: August 31, 2015

Report Issue Date: August 5, 2016

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 15 pages

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1 GENERAL

1.1 Purpose

The purpose of this report is to demonstrate compliance of the 902 to 928 MHz ISM band radio with Part 15 Subpart C of the FCC's Code of Federal Regulations.

1.2 Product Description

The Universal Meter Reader (UMR) system allows businesses and municipal agencies to read many of the leading water, power and gas meters that broadcast consumption information on the 900MHz ISM band. The UMR collects consumption data and transmits the data over one of many communication interfaces and is received by ILS Technology LLC's meter management cloud platform service using mesh network technology and a gateway device.

The UMR software radio currently reads Itron and Badger meters. UMR can dynamically switch which meter type to read. Support for reading other meter types is also supported.

Ethernet: Connect UMR to any internet connection using the optional external Ethernet connector. Connect directly to a router, a WiMax CPE or any other communications device that provides WAN access via an Ethernet connection.
WiFi: Connect to the WAN network over WiFi when available. Also, configure UMR over a web interface.
Mesh Networking: Build a network topology that allows many devices to share a single WAN connection via 900 MHz 802.15.4 mesh networking. The following encoding schemes are available:

- 40kbit – 1 mile between nodes
- 250kbit – ½ mile between nodes

Technical Information:

Detail	Description
Frequency Range	906 MHz
Number of Channels	1
Modulation Format	FSK
Data Rates	40kbit/ 250kbit
Number of Inputs/Outputs	1
Antenna Type / Gain (1)	5/8 wave over 5/8 wave colinear / 5dBi

Manufacturer Information:
ILS Technology LLC
5300 Broken Sound Blvd NW #150
Boca Raton, FL 33487

EUT Serial Numbers: 60 and 62

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

1.3 Test Methodology and Considerations

This report covers only the 902 to 928 MHz ISM band radio. The other radio interface is a 2.4 GHz WIFI radio, approved as FCC ID: 2AFWA-UMR-1.

The manufacturer provided test software to both, set parameters and exercise the EUT.

The EUT was tested in its normal orientation.

The EUT has 2 data rates, when required, test data for both data rates is provided.

The WIFI and Ethernet model variants were both evaluated for intentional emissions. The worst case emissions were from the version without the Ethernet port connected.

The WIFI and Ethernet model variants were both evaluated for unintentional emissions. The evaluation for unintentional emissions is documented separately in a verification report.

The UMR-2 is co-located with the WIFI transceiver, FCC ID: 2AFWA-UMR-1. Radiated inter-modulation products were evaluated for all combinations of simultaneous transmission between the radios. All emissions were found to be in compliance.

2 Test Facility

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:

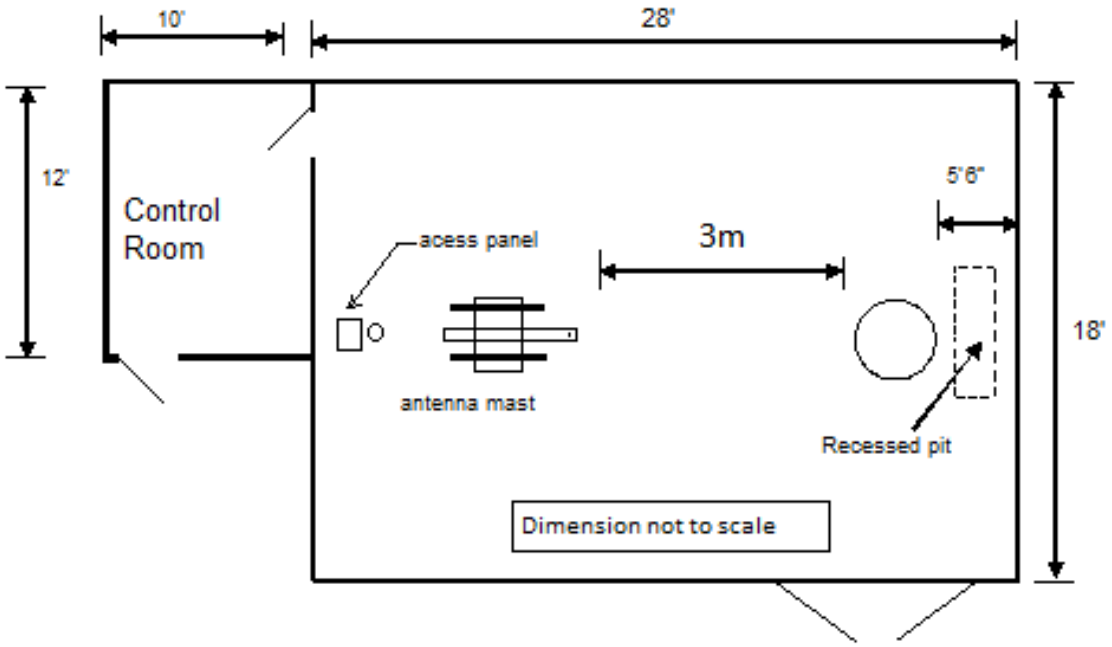

Figure 2.3-1: Semi-Anechoic Chamber Test Site

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:

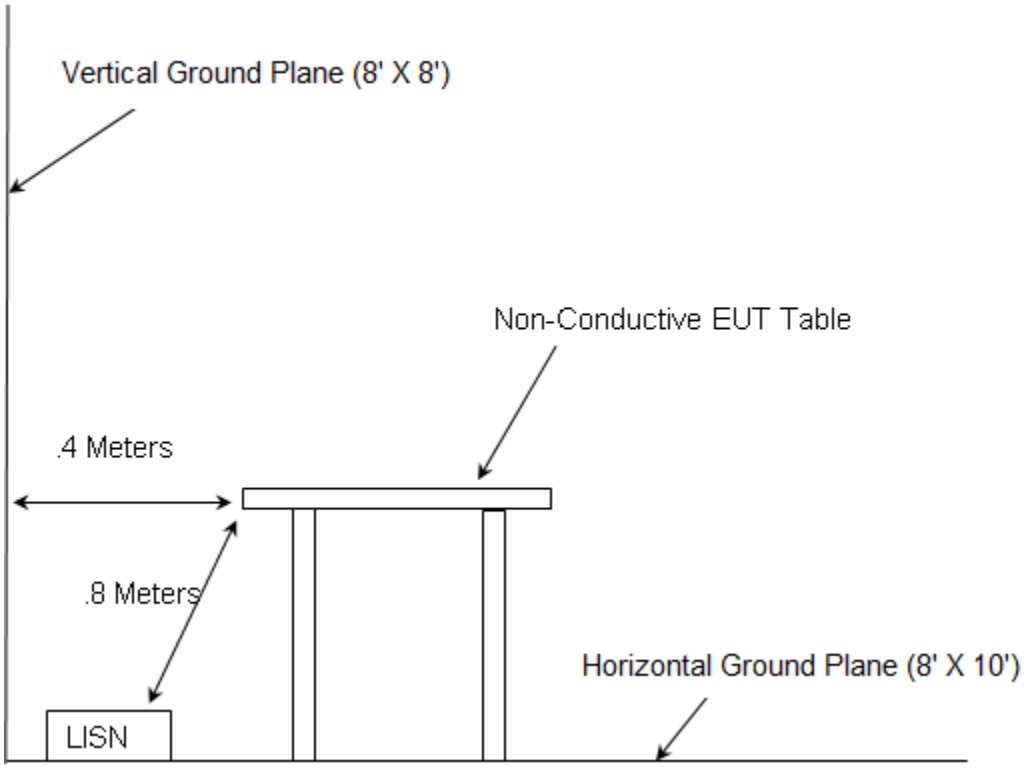

Figure 2.4-1: AC Mains Conducted EMI Site

3 APPLICABLE STANDARD REFERENCES

The following standards were used:

- ANSI C63.4-2014 - American National Standard for Methods of Measurement of Radio-Noise Emissions from low-voltage electrical and electronic equipment in the range of 9kHz 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
- FCC KDB 558074 D01 DTS Meas Guidance v03r05 - Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247, January 7, 2016

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
277	Emco	93146	Antennas	9904-5199	9/2/2014	9/2/2016
626	EMCO	3110B	Antennas	9411-1945	2/26/2014	2/26/2016
3002	Rohde & Schwarz	ESU40	Receiver	100346	7/6/2015	7/6/2016
3006	Rohde & Schwarz	TS-PR18	Amplifiers	122006	6/29/2015	6/29/2016
3007	Rohde & Schwarz	TS-PR26	Amplifiers	100051	6/29/2015	6/29/2016
3008	Rohde & Schwarz	NRP2	Meter	103131	1/15/2015	1/15/2016
3009	Rohde & Schwarz	NRP-Z81	Meter	102397	1/15/2015	1/15/2016
3011	Rohde & Schwarz	ENV216	LISN	3011	7/10/2015	7/10/2016
3012	Rohde & Schwarz	EMC32-EB	Software	100731	NCR	NCR
3016	Fei Teng Wireless Technology	HA-07M18G-NF	Antennas	2013120203	1/14/2015	1/14/2016
3027	Micro-Tronics	BRM50702	Filter	175	1/17/2015	1/17/2016
3033	Hasco, Inc.	HLL142-S1-S1-36	Cables	1435	1/15/2015	1/15/2016
3038	Florida RF Labs	NMSE-290AW-60.0-NMSE	Cable Set	1448	1/12/2015	1/12/2016
3045	Aeroflex Inmet	18N10W-20	Attenuator	1437	1/18/2015	1/18/2016
3051	Mountain View Cable	BMS-RG400-264.0-BMS	Cables	3051	1/12/2015	1/12/2016
3055	Rohde & Schwarz	3005	Cables	3055	1/16/2015	1/16/2016
3057	Advanced Technical Materials	42-441-6/BR	Antennas	R110602	NCR	NCR

DMAS MT-25 RF absorber material was used on the floor for all final measurements above 1 GHz.
NCR = No Calibration Required
Firmware Version: ESU40 is 4.73 SP4
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	ILS Tech LLC	UMR-2	62, 60

Notes:

6 EQUIPMENT UNDER TEST SETUP BLOCK DIAGRAM

6.1 Block Diagram

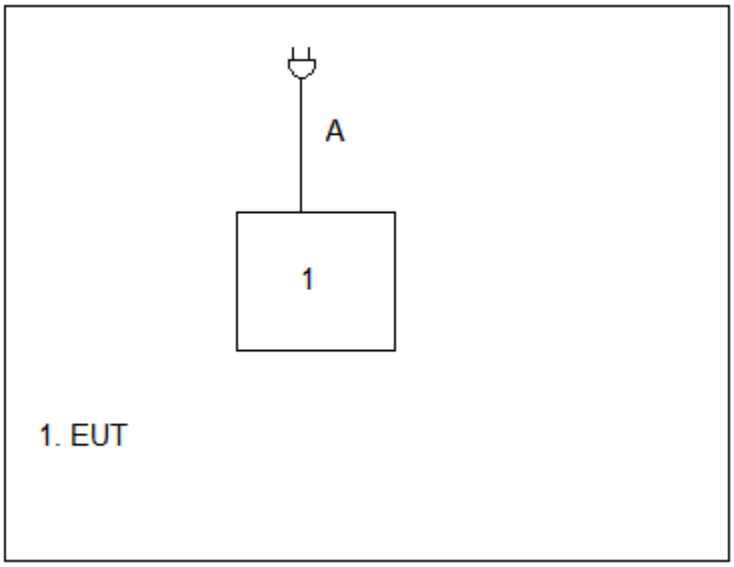

Figure 6-1: Test Setup Block Diagram

Table 6-1: Cable Description

Cable #	Cable Type	Length	Shield	Termination
A	EUT to AC Mains	2.5m	No	AC Mains

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 antenna is removable and has an NMO connector.
The peak gain of the antenna is 5 dBi.

The manufacturer declares that the product qualifies for exemption to 15.203 and will provide documentation that it is professionally installed equipment.

7.2 Power Line Conducted Emissions – FCC 15.207

7.2.1 Measurement Procedure

ANSI C63.4-2014 sections 6 and 7 were the guiding documents for this evaluation. Conducted emissions were performed from 150 kHz to 30 MHz with the spectrum analyzer's resolution bandwidth set to 9 kHz and the video bandwidth set to 30 kHz. The calculation for the conducted emissions is as follows:

Corrected Reading = Analyzer Reading + LISN Loss + Cable Loss
Margin = Applicable Limit - Corrected Reading

7.2.2 Measurement Results

Both the transmitters were turned on and there was no significant difference between the different data rates.

Table 7.2.2-1: Conducted EMI Results – Line 1

Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Filter	Corr. (dB)
0.154500	---	34.43	55.73	21.30	1000.0	9.000	L1	OFF	9.7
0.154500	51.76	---	65.73	13.97	1000.0	9.000	L1	OFF	9.7
0.433500	---	27.12	47.09	19.97	1000.0	9.000	L1	OFF	9.7
0.433500	35.92	---	57.10	21.18	1000.0	9.000	L1	OFF	9.7
0.784500	---	17.40	46.00	28.60	1000.0	9.000	L1	OFF	9.7
0.784500	23.47	---	56.00	32.53	1000.0	9.000	L1	OFF	9.7
1.322250	---	10.92	46.00	35.08	1000.0	9.000	L1	OFF	9.8
1.322250	16.70	---	56.00	39.30	1000.0	9.000	L1	OFF	9.8
18.685500	---	17.77	50.00	32.23	1000.0	9.000	L1	OFF	11.0
18.685500	23.85	---	60.00	36.15	1000.0	9.000	L1	OFF	11.0

Table 7.2.2-2: Conducted EMI Results – Neutral

Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Filter	Corr. (dB)
0.150000	---	33.82	56.00	22.18	1000.0	9.000	N	OFF	9.7
0.150000	51.05	---	66.00	14.95	1000.0	9.000	N	OFF	9.7
0.442500	---	25.49	46.93	21.44	1000.0	9.000	N	OFF	9.7
0.442500	34.17	---	56.94	22.77	1000.0	9.000	N	OFF	9.7
0.453750	---	27.91	46.74	18.83	1000.0	9.000	N	OFF	9.7
0.453750	35.18	---	56.75	21.57	1000.0	9.000	N	OFF	9.7
17.871000	---	16.06	50.00	33.94	1000.0	9.000	N	OFF	10.7
17.871000	21.21	---	60.00	38.79	1000.0	9.000	N	OFF	10.7

7.3 6dB Bandwidth – FCC 15.247(a)(2)

7.3.1 Measurement Procedure

The 6 dB 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.

7.3.2 Measurement Results

Table 7.3.2-1: 6dB

Frequency [MHz]	6dB Bandwidth [kHz]	Data Rate (kbps)
906	500.00	40k
906	872.98	250k

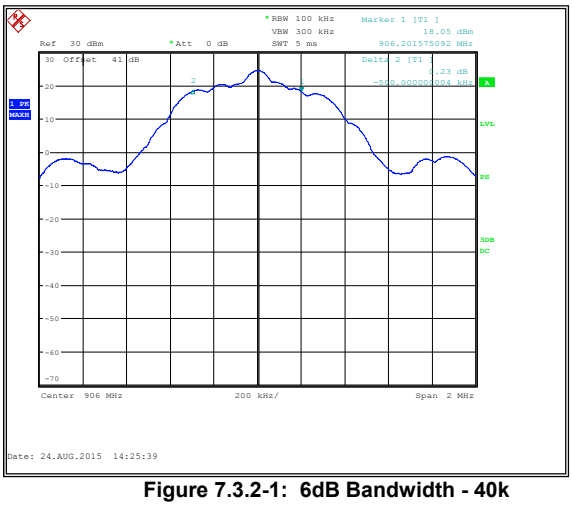

Figure 7.3.2-1: 6dB Bandwidth - 40k

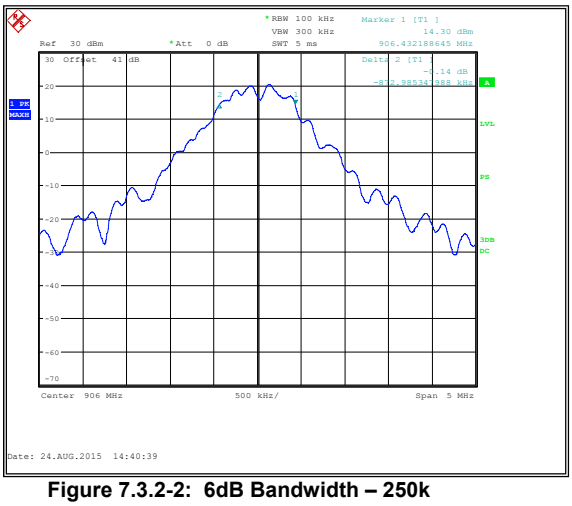

Figure 7.3.2-2: 6dB Bandwidth – 250k

7.4 Fundamental Emission Output Power – FCC 15.247(b)(3)

7.4.1 Measurement Procedure

The maximum peak conducted output power was measured in accordance with FCC KDB 558074 D01 DTS Meas 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 power meter applying suitable attenuation.

7.4.2 Measurement Results

Table 7.4.2-1: Maximum Peak Conducted Output Power

Frequency (MHz)	Data Rate (kbps)	Output Power (dBm)	Output Power (Watts)
906	40	22.25	0.168
906	250	23.8	0.240

7.5 Emission Levels – FCC 15.247(d), 15.205, 15.209

7.5.1 Emissions into Non-restricted Frequency Bands

7.5.1.1 Measurement Procedure

The unwanted emissions into non-restricted bands were measured conducted in accordance with FCC KDB 558074 D01 DTS Measurement Guidance v03r05. 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 30 MHz to 25 GHz. Additionally a prescan was performed from 9 kHz or the lowest frequency generated to 30 MHz.

7.5.1.2 Measurement Results

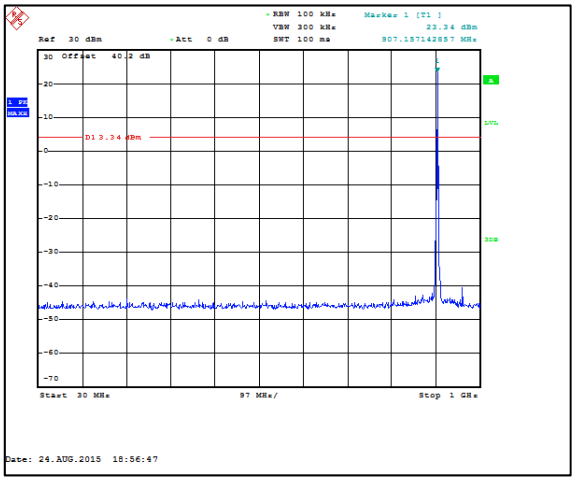

Figure 7.5.1.2-1: Below 1GHz

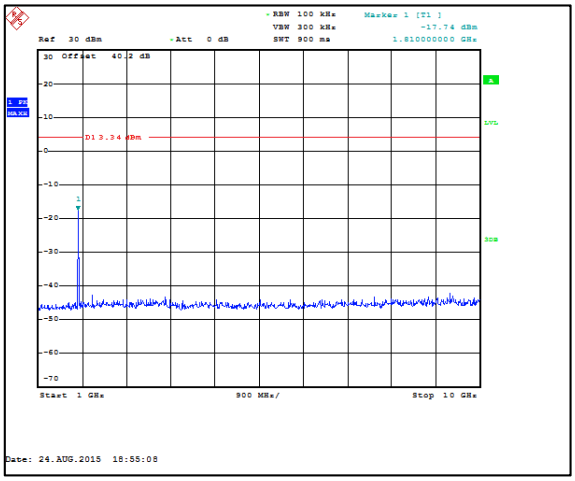

Figure 7.5.1.2-2: Above 1GHz

7.5.2 Band-Edge Compliance and Spurious Emissions

7.5.2.1 Band-Edge Compliance of RF Conducted Emissions - FCC 15.247(d)

7.5.2.2 Measurement Procedure

The RF output port of the EUT was directly connected to the input of the spectrum analyzer. 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 greater than the RBW.

7.5.2.3 Measurement Results

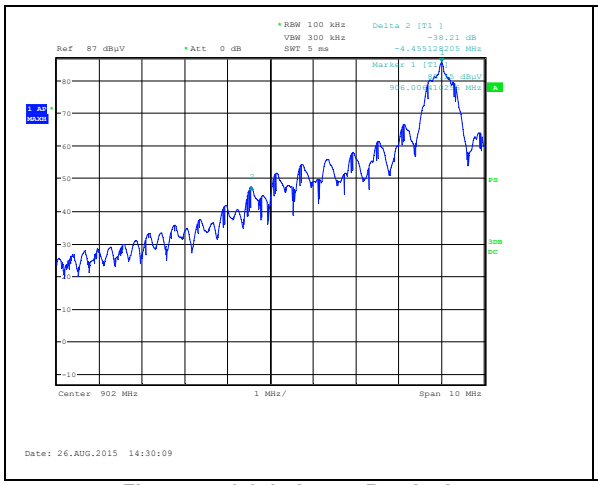

Figure 7.5.2.2-1: Lower Band-edge – 40 kbps Data Rate

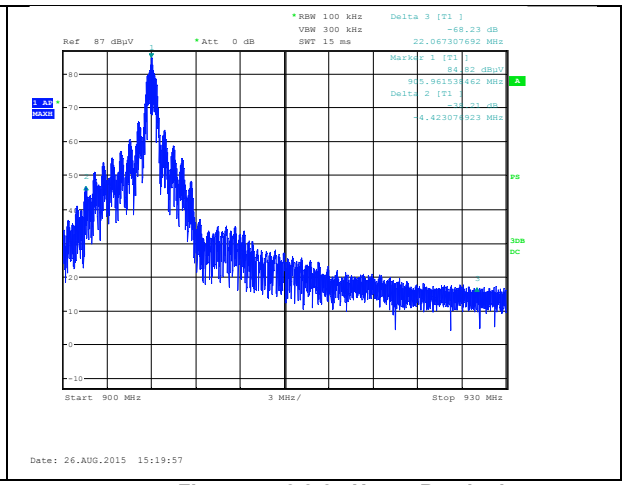

Figure 7.5.2.2-2: Upper Band-edge – 40 kbps Data Rate

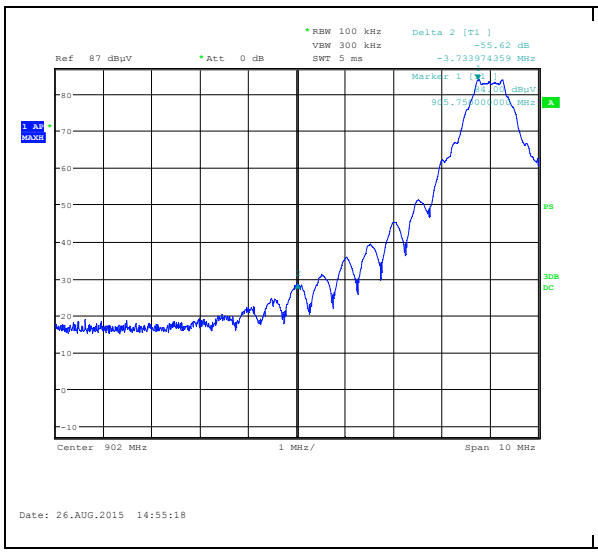

Figure 7.5.2.2-3: Lower Band-edge – 250 kbps Data Rate

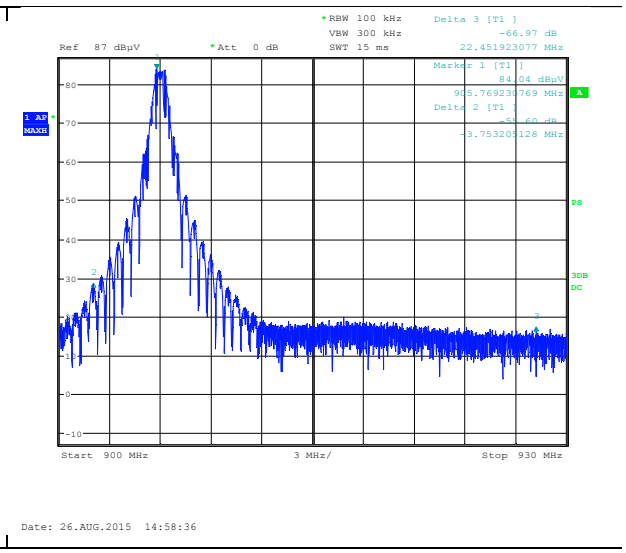

Figure 7.5.2.2-4: Upper Band-edge – 250 kbps Data Rate

7.5.3 Emissions into Restricted Frequency Bands

7.5.3.1 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 1m to 4m so that the maximum radiated emissions level would be detected. For frequencies below 1000 MHz, quasi-peak measurements were made using a RBW of 120 kHz and a 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.

7.5.3.2 Duty Cycle Correction

The Duty Cycle Correction was not required.

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
40k Data Rate										
2718	45.30	36.20	V	-0.32	44.98	35.88	74.0	54.0	29.0	18.1
3624	35.20	29.00	V	3.24	38.44	32.24	74.0	54.0	35.6	21.8
250k Data Rate										
2718	45.30	36.20	V	-0.32	44.98	35.88	74.0	54.0	29.0	18.1
3624	35.20	29.00	V	3.24	38.44	32.24	74.0	54.0	35.6	21.8

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: 45.30 + -0.32 = 44.98 dBuV/m
Margin: 74dBuV/m – 44.98 dBuV/m = 29.02 dB

Example Calculation: Average

Corrected Level: 36.20 + -0.32 = 35.88 dBuV/m
Margin: 54dBuV – 35.88 dBuV/m = 18.12 dB

7.6 Power Spectral Density – FCC 15.247(e)

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 30 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)	Data Rate (kbps)	PSD Level (dBm)
906	40	7.74
906	250	7.63

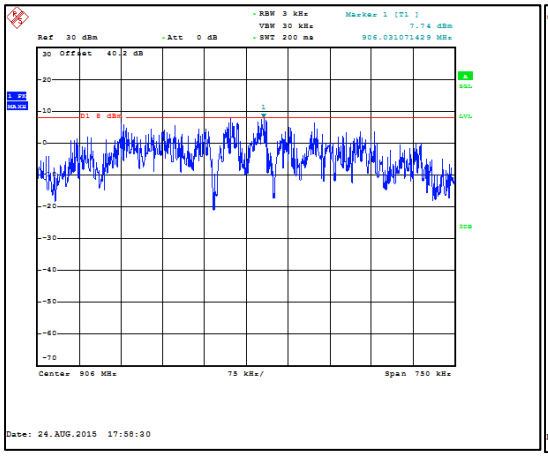

Figure 7.6.2-1: PSD Plot

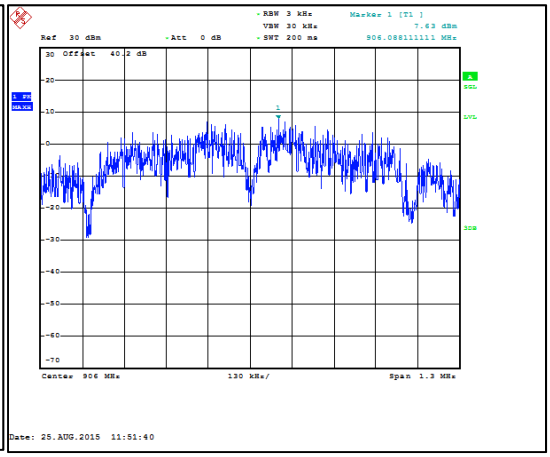

Figure 7.6.2-2: PSD Plot

8 CONCLUSION

In the opinion of ACS, Inc. the UMR-2, manufactured by ILS Technology LLC meets the requirements of FCC Part 15 subpart C.

END REPORT