Excellence in Compliance Testing

Certification Test Report

FCC ID: SM6-HOTRODV2ML
IC: 9235A-HOTRODV2ML

FCC Rule Part: 15.249
IC Radio Standards Specification: RSS-210

ACS Report Number: 12-0115.W06.3B

Manufacturer: Mueller Systems
Model: AHRML-DL

Test Begin Date: March 23, 2012
Test End Date: April 20, 2012

Report Issue Date: May 18, 2012

FOR THE SCOPE OF ACCREDITATION UNDER LAB Code 200612-0

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

Reviewed by:

Kirby Munroe
Director, Wireless Certifications
ACS, Inc.

This report contains 15 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-210.

1.2 Product description

The AHRML-DL remote meter reading transmitter was designed to allow the utility to receive data from any Mueller water meter equipped with a Translator register. The transmitter collects data from the register and transmits it via radio frequency (RF) to be collected by a mobile receiver. The AHRML-DL high power unit is designed for use with the specific meter pit and meter lid described in this report.

Band of operation:	902 – 928 MHz
Modulation format:	GFSK
Antenna Type/Gain:	1/4 wavelength whip; -0.5dBi
Operating Voltage:	3.6VDC (Battery)

Manufacturer Information:
Mueller Systems
1200 Abernathy Road, NE Suite 1200
Atlanta, GA 30328

Test Sample Serial Number(s): 12/03

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

1.3 Test Methodology and Considerations

For radiated emissions the EUT was tested in an orientation representative of typical installation. The EUT is intended for meter pit installation at or below ground level. Testing was performed as typically installed in meter pits described in sections 5.0 – 6.0. A 4'x4'x4' dirt filled wooden test fixture (box) was used to simulate typically in-ground in use. The EUT is battery powered therefore AC power line conducted emissions was not performed.

The power setting of the EUT was adjusted to meet the field strength limitations of Part 15.249 as follows:

Cast Iron Pit / Cast Iron Lid: Power Setting 6

2 TEST FACILITIES

2.1 Location

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

Advanced Compliance Solutions
5015 B.U. Bowman Drive
Buford, GA 30518
Phone: (770) 831-8048
Fax: (770) 831-8598

2.2 Laboratory Accreditations/Recognitions/Certifications

ACS is accredited to ISO/IEC 17025 by the National Institute of Standards and Technology under their National Voluntary Laboratory Accreditation Program (NVLAP), Lab Code 200612-0. Unless otherwise specified, all tests methods described within this report are covered under the ISO/IEC 17025 scope of accreditation.

The Semi-Anechoic Chamber Test Site, Open Area Test Site (OATS) and Conducted Emissions Site have been fully described, submitted to, and accepted by the FCC, Industry Canada and the Japanese Voluntary Control Council for Interference by information technology equipment.

FCC Registration Number: 511277
Industry Canada Lab Code: 4175A-1
VCCI Member Number: 1831

- VCCI OATS Registration Number R-1526
- VCCI Conducted Emissions Site Registration Number: C-1608

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' x 30' x 18' shielded enclosure. The chamber is lined with Toyo Ferrite Grid Absorber, model number FFG-1000. The ferrite tile grid is 101 x 101 x 19mm thick and weighs approximately 550 grams. These tiles are mounted on steel panels and installed directly on the inner walls of the chamber.

The turntable is 150cm in diameter and is located 160cm 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 3/4" stainless steel braided cable.

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 range. 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 during operation.

Behind the turntable is a 3' x 6' x 4' deep shielded pit used for support equipment if necessary. The pit is equipped with 1 - 4" PVC chases 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:

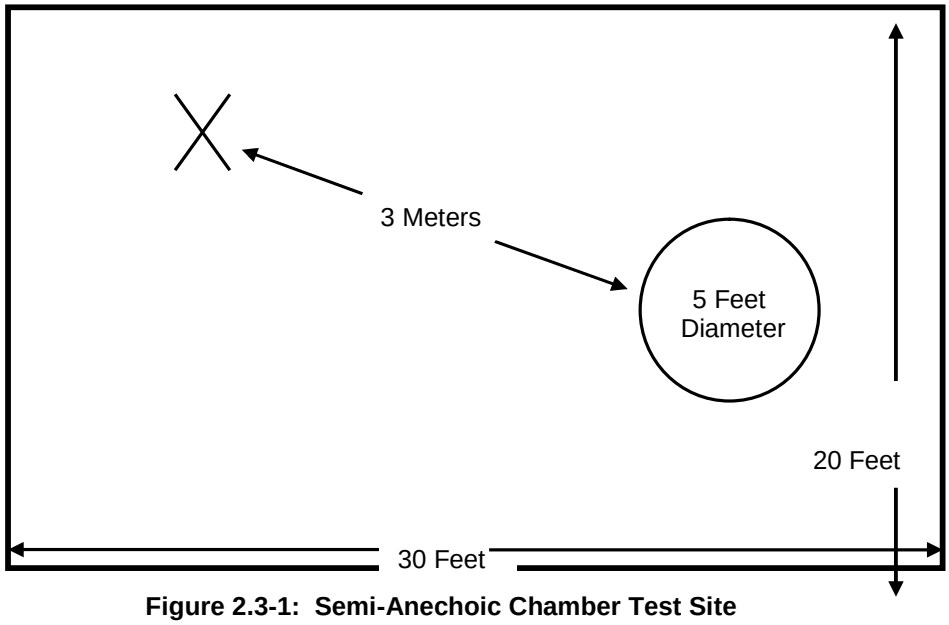


Figure 2.3-1: Semi-Anechoic Chamber Test Site

2.3.2 Open Area Tests Site (OATS)

The open area test site consists of a 40' x 66' concrete pad covered with a perforated electro-plated galvanized sheet metal. The perforations in the sheet metal are 1/8" holes that are staggered every 3/16". The individual sheets are placed to overlap each other by 1/4" and are riveted together to provide a continuous seam. Rivets are spaced every 3" in a 3 x 20 meter perimeter around the antenna mast and EUT area. Rivets in the remaining area are spaced as necessary to properly secure the ground plane and maintain the electrical continuity.

The entire ground plane extends 12' beyond the turntable edge and 16' beyond the antenna mast when set to a 10 meter measurement distance. The ground plane is grounded via 4 - 8' copper ground rods, each installed at a corner of the ground plane and bound to the ground plane using 3/4" stainless steel braided cable.

The turntable is an all aluminum 10' flush mounted table installed in an all aluminum frame. The table is remotely operated from inside the control room located 40' from the range. 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 during operation.

Adjacent to the turntable is a 7' x 7' square and 4' deep concrete pit used for support equipment if necessary. The pit is equipped with 5 - 4" PVC chases from the pit to the control room 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. The pit is covered with 2 sheets of 1/4" diamond style re-enforced steel sheets. The sheets are painted to match the perforated steel ground plane; however the underside edges have been masked off to maintain the electrical continuity of the ground plane. All reflecting objects are located outside of the ellipse defined in ANSI C63.4.

A diagram of the Open Area Test Site is shown in Figure 2.3-2 below:

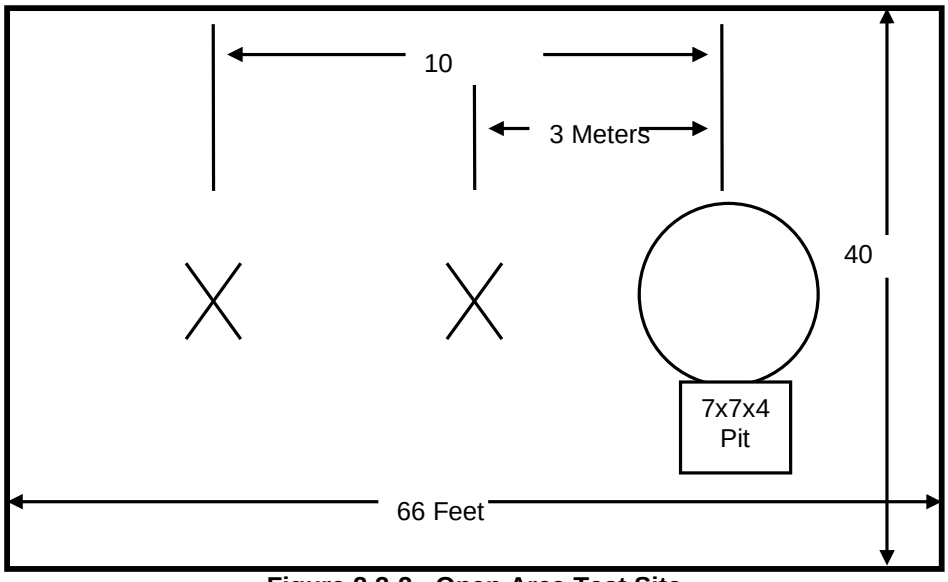


Figure 2.3-2: Open Area Test Site

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 8' solid aluminum horizontal ground reference plane (GRP) bonded every 3" to an 8' X 8' vertical ground plane.

The site is of sufficient size to test table top and floor standing equipment in accordance with section 6.1.4 of ANSI C63.4.

A diagram of the room is shown below in figure 4.1.3-1:

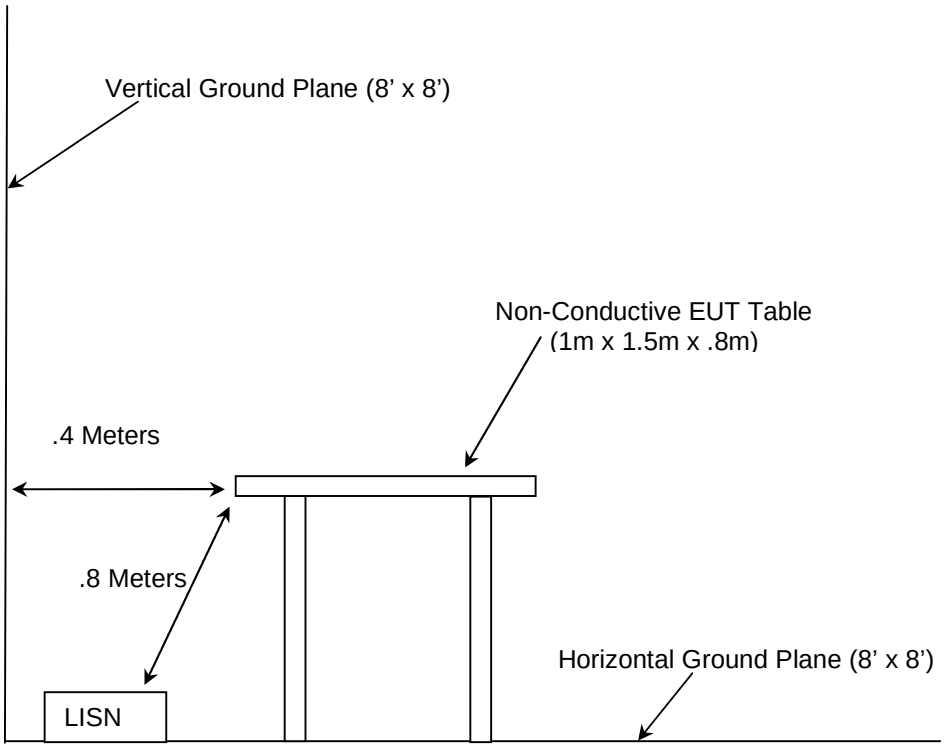


Figure 2.4-1: AC Mains Conducted EMI Site

3 APPLICABLE STANDARD REFERENCES

The following standards were used:

- ANSI C63.4-2003: Method of Measurements of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the 9KHz to 40GHz
- US Code of Federal Regulations (CFR): Title 47, Part 2, Subpart J: Equipment Authorization Procedures, 2011
- US Code of Federal Regulations (CFR): Title 47, Part 15, Subpart C: Radio Frequency Devices, Intentional Radiators, 2011
- Industry Canada Radio Standards Specification: RSS-210 - Low-power License-exempt Radiocommunication Devices (All Frequency Bands): Category I Equipment, Issue 8, December 2010
- Industry Canada Radio Standards Specification: RSS-GEN – General Requirements and Information for the Certification of Radiocommunication Equipment, Issue 3, December 2010.

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

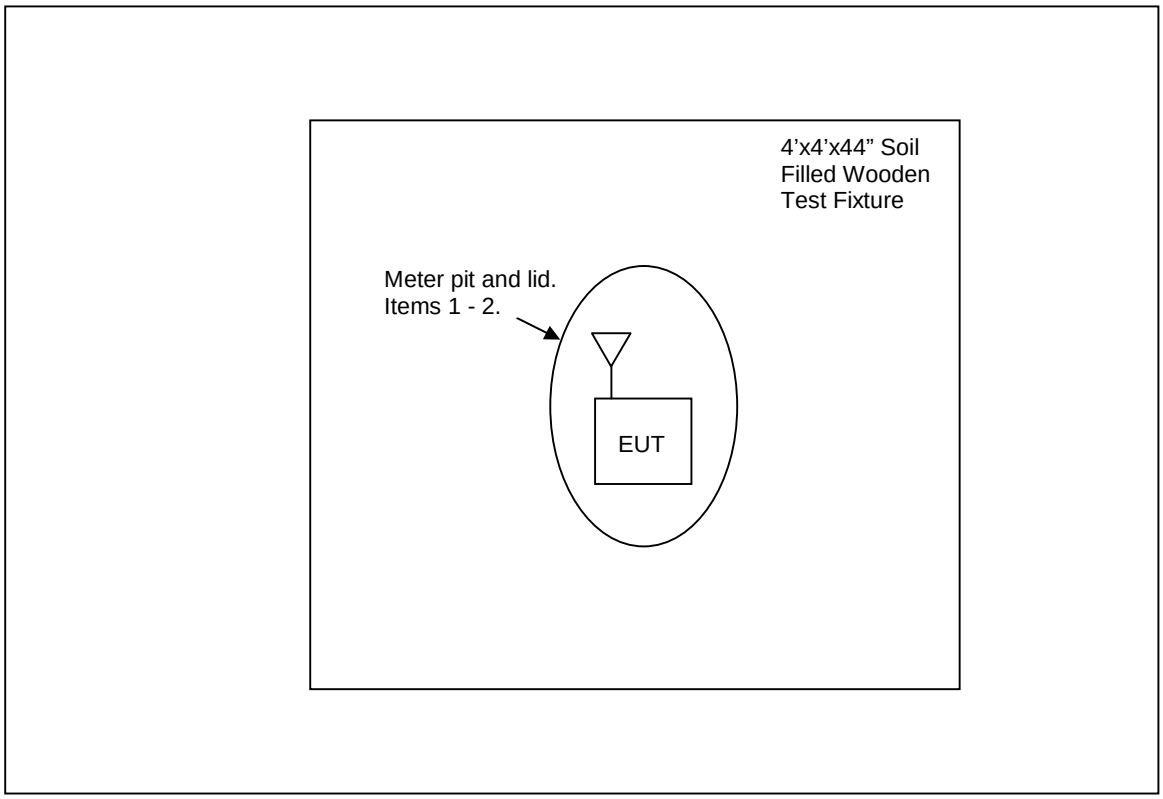
AssetID	Manufacturer	Model #	Equipment Type	Serial #	Last Calibration Date	Calibration Due Date
22	Agilent	8449B	Amplifiers	3008A00526	8/26/2011	8/26/2012
40	EMCO	3104	Antennas	3211	2/11/2011	2/11/2013
193	ACS	OATS cable Set	Cable Set	193	1/9/2012	7/9/2012
211	Eagle	C7RFM3NFNM	Filters	HLC-700	12/1/2011	12/1/2012
213	TEC	PA 102	Amplifiers	44927	8/23/2011	8/23/2012
277	Emco	93146	Antennas	9904-5199	8/25/2010	8/25/2012
283	Rohde & Schwarz	FSP40	Spectrum Analyzers	1000033	8/26/2011	8/26/2012
329	A.H.Systems	SAS-571	Antennas	721	6/24/2011	6/24/2013
329	A.H.Systems	SAS-571	Antennas	721	6/24/2011	6/24/2013
331	Microwave Circuits	H1G513G1	Filters	31417	7/16/2010	7/16/2011
331	Microwave Circuits	H1G513G1	Filters	31417	7/11/2011	7/11/2012
343	Florida RF Cables	SMRE-200W-12.0-SMRE	Cables	N/A	4/15/2011	4/15/2012
343	Florida RF Cables	SMRE-200W-12.0-SMRE	Cables	N/A	4/2/2012	4/2/2013
430	RF Cables	SMS-290AW-480-SMS	Cables	N/A	4/15/2011	4/15/2012
430	RF Cables	SMS-290AW-480-SMS	Cables	N/A	4/2/2012	4/2/2013
486	Hewlett Packard	8591E	Analyzers	3543A04709	5/26/2011	5/26/2012

5 SUPPORT EQUIPMENT

Table 5-1: Support Equipment

Item	Equipment Type	Manufacturer	Model Number	Serial Number
1	Meter Pit (Cast Iron)	Mueller	H-1462 Stretch Box	N/A
2	Meter Lid (Cast Iron)	Mueller	C682402 Cast Iron Lid	N/A

6 EQUIPMENT UNDER 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: Section 15.203

The AHRML-DL utilizes a quarter wavelength whip antenna with a gain of -0.5dBi soldered directly to the PCB board thus satisfying the unique antenna coupling specified in Part 15.203.

7.2 Power Line Conducted Emissions – FCC: Section 15.207 IC: RSS-Gen 7.2.4

7.2.1 Measurement Procedure

The EUT is a battery operated device therefore AC power line conducted emissions is not applicable.

7.3 20dB / 99% Bandwidth – FCC: Section 15.215, IC: RSS-Gen 4.6.1

7.3.1 Measurement Procedure

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 approximately 1 % to 5 % of the OBW. The 20dB bandwidth was measured between the lower and upper points on the emission which correspond to 20dB below the reference level previously established.

The 99% occupied bandwidth was measured with the spectrum analyzer span set to fully display the emission and side bands. The RBW was to ~ 1% of the span. The trace was set to max hold with a sample detector. The occupied bandwidth measurement function of the analyzer was used for the 99% bandwidth.

7.3.2 Measurement Results

Results are shown below in table 7.3.2-1 and figure 7.3.2-1 to 7.3.2-6:

Table 7.3.2-1: 20dB / 99% Bandwidth

Frequency [MHz]	20dB Bandwidth [kHz]	99% Bandwidth [kHz]
905	102.6	100.8
915	102.0	99.6
925	103.2	99.6

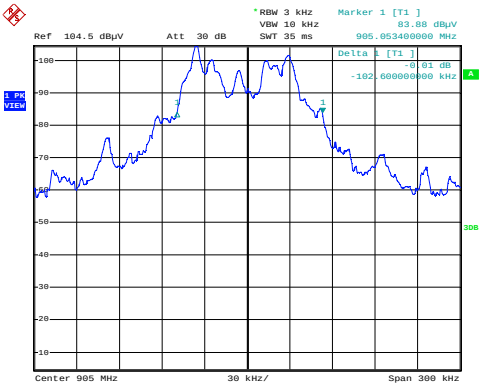


Figure 7.3.2-1: 20dB Bandwidth Plot – 905MHz

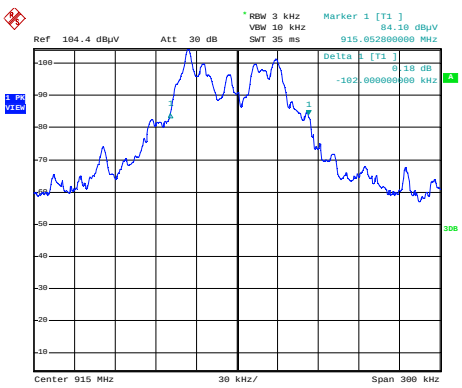


Figure 7.3.2-2: 20dB Bandwidth Plot – 915MHz

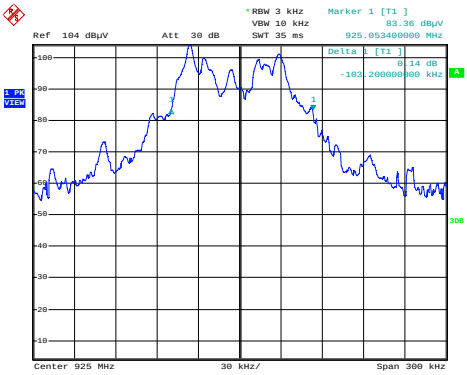


Figure 7.3.2-3: 20dB Bandwidth Plot – 925MHz

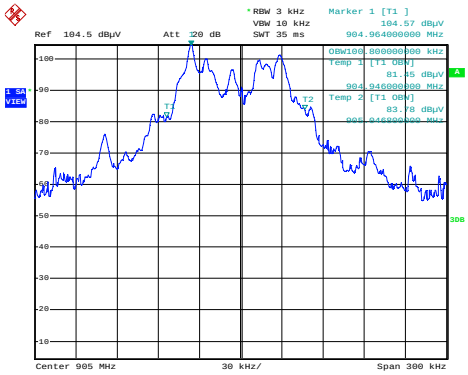


Figure 7.3.2-4: 99% Bandwidth Plot – 905MHz

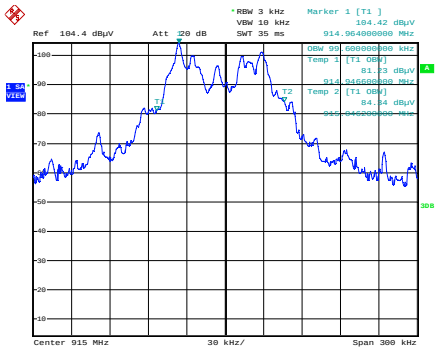


Figure 7.3.2-5: 99% Bandwidth Plot – 915MHz

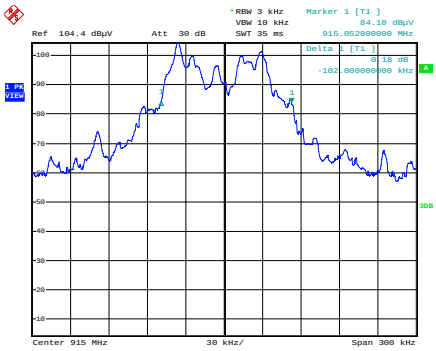


Figure 7.3.2-6: 99% Bandwidth Plot – 925MHz

7.4 Fundamental Field Strength – FCC: Section 15.249(a) IC: RSS-210 A2.9(a)

7.4.1 Measurement Procedure

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 fundamentals below 1GHz, quasi-peak measurements were made using a resolution bandwidth (RBW) of 120 kHz and a video bandwidth (VBW) of 300 kHz. For fundamentals above 1GHz, peak and average measurements were made using a resolution bandwidth (RBW) of 1 MHz and a video bandwidth (VBW) of 3 MHz.

7.4.2 Measurement Results

Results are shown below in Table 7.4.2-1.

Table 7.4.2-1: Fundamental Field Strength

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
905		80.03	H	2.80	---------	82.83	--------	94.0	---------	11.1
905		90.04	V	2.80	---------	92.84	--------	94.0	---------	1.1
915		81.28	H	3.30	---------	84.58	--------	94.0	---------	9.4
915		87.95	V	3.30	---------	91.25	--------	94.0	---------	2.7
925		81.01	H	3.55	---------	84.56	--------	94.0	---------	9.4
925		87.47	V	3.55	---------	91.02	--------	94.0	---------	3.0

7.5 Radiated Spurious Emissions - FCC: Section 15.249(a)(d)(e); IC:RSS-210 A2.9(a)(b)

7.5.1 Measurement Procedure

Radiated emissions tests were made over the frequency range of 30MHz 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 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 3 MHz respectively. The average emissions were further corrected by applying the duty cycle correction of the EUT for comparison to the average limit.

All out of band emissions were evaluated, including any emissions at or near the band-edge.

7.5.2 Duty Cycle Correction

For average radiated measurements, using a 10% duty cycle, the measured level was reduced by a factor 20dB. The duty cycle correction factor is determined using the formula: 20log (10/100) = -20dB.

A detailed analysis of the duty cycle timing is provided in the Theory of Operation accompanying this report.

7.5.3 Measurement Results

Radiated spurious emissions found in the band of 30MHz to 10GHz are reported in the tables 7.5.3-1 to 7.5.3-3 below.

Table 7.5.3-1: Radiated Spurious Emissions Tabulated Data – 905MHz

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
1810	50.15	50.15	H	-7.91	42.24	22.24	74.0	54.0	31.8	31.8
1810	52.90	52.90	V	-7.91	44.99	24.99	74.0	54.0	29.0	29.0
2715	48.90	48.90	H	-4.44	44.46	24.46	74.0	54.0	29.5	29.5
2715	51.02	51.02	V	-4.44	46.58	26.58	74.0	54.0	27.4	27.4
3620	52.27	52.27	H	-2.39	49.88	29.88	74.0	54.0	24.1	24.1
3620	55.92	55.92	V	-2.39	53.53	33.53	74.0	54.0	20.5	20.5

Table 7.5.3-2: Radiated Spurious Emissions Tabulated Data – 915MHz

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
1830	51.42	51.42	H	-7.73	43.69	23.69	74.0	54.0	30.3	30.3
1830	54.73	54.73	V	-7.73	47.00	27.00	74.0	54.0	27.0	27.0
2745	50.73	50.73	H	-4.38	46.35	26.35	74.0	54.0	27.7	27.7
2745	53.32	53.32	V	-4.38	48.94	28.94	74.0	54.0	25.1	25.1
3660	53.86	53.86	H	-2.18	51.68	31.68	74.0	54.0	22.3	22.3
3660	56.95	56.95	V	-2.18	54.77	34.77	74.0	54.0	19.2	19.2
4575	49.76	49.76	V	0.13	49.89	29.89	74.0	54.0	24.1	24.1

Table 7.5.3-3: Radiated Spurious Emissions Tabulated Data – 925MHz

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
1850	52.15	52.15	H	-7.54	44.61	24.61	74.0	54.0	29.4	29.4
1850	53.42	53.42	V	-7.54	45.88	25.88	74.0	54.0	28.1	28.1
2775	51.44	51.44	H	-4.33	47.11	27.11	74.0	54.0	26.9	26.9
2775	52.58	52.58	V	-4.33	48.25	28.25	74.0	54.0	25.8	25.8
3700	52.64	52.64	H	-1.96	50.68	30.68	74.0	54.0	23.3	23.3
3700	55.43	55.43	V	-1.96	53.47	33.47	74.0	54.0	20.5	20.5
4625	50.61	50.61	V	0.31	50.92	30.92	74.0	54.0	23.1	23.1

7.5.4 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: 50.15 - 7.91 = 42.24dBuV
Margin: 74dBuV – 42.24dBuV = 31.8dB

Example Calculation: Average

Corrected Level: 50.15 - 7.91 - 20 = 22.24dBuV
Margin: 54dBuV – 22.24dBuV = 31.8dB

8 CONCLUSION

In the opinion of ACS, Inc. the AHRML-DL, manufactured by Mueller Systems meets the requirements of FCC Part 15 subpart C and Industry Canada's Radio Standards Specification RSS-210.

END REPORT