



Wireless Test Report

**FCC ID: SM6-MINODE-WATER4
IC: 9235A-MINODE4**

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

TÜV SÜD Report Number: TP72125538.200

**Manufacturer: Mueller Systems, LLC
Model: MINODE-WATER4 / EchoShore-DX**

**Test Begin Date: February 24, 2017
Test End Date: March 09, 2017**

Report Issue Date: March 30, 2017



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.

Prepared by:

A handwritten signature in black ink, appearing to read 'Jean Tezil'.

**Jean Tezil
EMC Engineer
TÜV SÜD America Inc.**

Reviewed by:

A handwritten signature in black ink, appearing to read 'Randy Sherian'.

**Randy Sherian
Lab Manager Durham (RTP)
TÜV SÜD America Inc.**

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2320 Presidential Drive Suite 101 Durham, NC 27703-8077 USA Voice: 919-381-4235

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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 ISED Canada's Radio Standards Specification RSS-247 for a Class II Permissive Change.

The changes to the device consist of its integration to a host system with a new PCB flex antenna. The host is powered with a 3.6VDC battery pack.

1.2 Product description

The host platform EchoShore-DX incorporates acoustic sensors built into a standard fire hydrant cap to allow early detection of acoustical noises associated with the presence of leaks. The EchoShore-DX integrates the MINODE-WATER4 module as a wireless component for remote monitoring. The MINODE-WATER4 is an ISM band 902 to 928 MHz transceiver module with a maximum output power of +30dBm used in a data collection system connected to a device such as a standard water meter register. The MINODE-WATER4 is a composite device operating under two modes utilizing frequency hopping and wideband digital modulation respectively.

Technical Information:

The 2 modes of operation are detailed as follows. Only mode 1 (FHSS) is addressed in this report

Mode of Operation	Frequency Range (MHz)	Number of Channels	Channel Separation (kHz)	Data Rates Supported (kbps)	Modulation
1	912.310059 - 927.012451	50	300	4557.3bps and 2604.2bps	FHSS, DSSS
2	903.649963 - 915.725525	24	525	10416.7bps	DTS, DSSS

Antenna Type: Flex antenna #160-101881

Antenna Gain (EIRP): -10.67dBi

Operating Voltage: 3.6Vdc

Power Settings: Highest power by default

Manufacturer Information:

Mueller Systems, LLC

1200 Abernathy Road, NE

Suite 1200

Atlanta, GA 30328

EUT Serial Numbers: 1612609249, 1523000014

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 evaluated installed in the host powered on battery and programmed to transmit continuously on the single channel respectively. The low, mid, and high channel were evaluated and are reported for the worse case data rate which is 2.6kbps. Only radiated emissions were performed to demonstrate that the integration to the new antenna/host system complies with FCC Rule Part 15.247 and IC RSS-247.

2 TEST FACILITIES

2.1 Location

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

TÜV SÜD America Inc.
2320 Presidential Drive, Suite 101
Durham, NC 27703
Phone: (919) 381-4235

2.2 Laboratory Accreditations/Recognitions/Certifications

TÜV SÜD America Inc. 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:

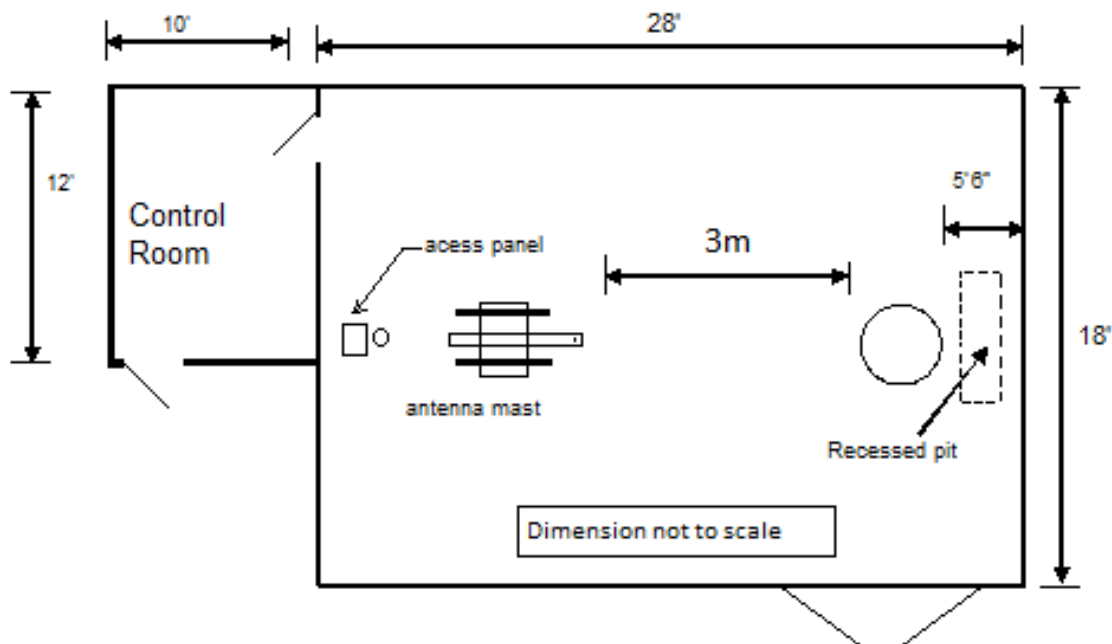


Figure 2.3-1: Semi-Anechoic Chamber Test Site

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:

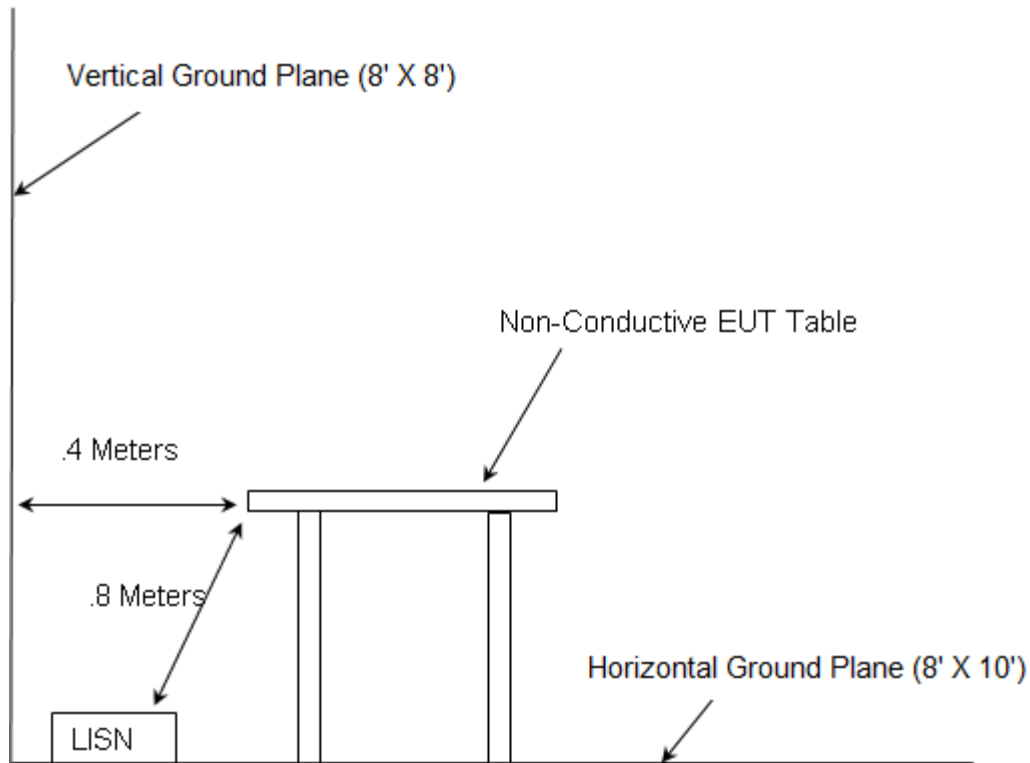


Figure 2.4-1: AC Mains Conducted EMI Site

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 15, Subpart C: Radio Frequency Devices, Intentional Radiators, 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 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 #	Last Calibration Date	Calibration Due Date
277	EMCO	93146	Antennas	9904-5199	9/12/2016	9/12/2018
731	EMCO	3104	Antennas	2659	11/09/2016	11/09/2018
3002	Rohde & Schwarz	ESU40	Receiver	100346	1/12/2017	1/12/2018
3006	Rohde & Schwarz	TS-PR18	Amplifiers	122006	1/11/2017	1/11/2018
3012	Rohde & Schwarz	EMC32-EB	Software	100731	NCR	NCR
3016	Fei Teng Wireless Technology	HA-07M18G-NF	Antennas	2013120203	1/26/2016	1/26/2018
3029	Micro-Tronics	HPM50108	Filter	134	1/13/2017	1/13/2018
3038	Florida RF Labs	NMSE-290AW-60.0-NMSE	Cable Set	1448	1/3/2017	1/3/2018
3039	Florida RF Labs	NMSE-290AW-396.0-NMSE	Cable Set	1447	1/3/2017	1/3/2018
3055	Rohde & Schwarz	3005	Cables	3055	1/3/2017	1/3/2018

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	Mueller	MINODE-WATER4	1612609249, 1523000014
2	Host	Mueller	EchoShore-DX	N/A

6 EQUIPMENT UNDER TEST SETUP BLOCK DIAGRAM

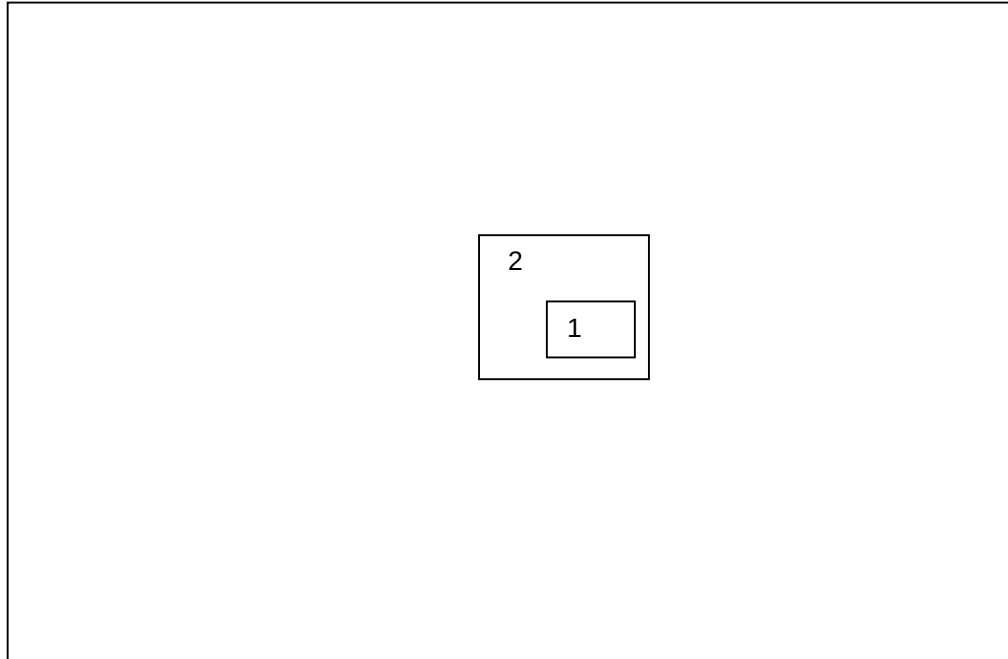


Figure 6-1: Test Setup Block Diagram

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 antenna is attached to the device using a UFL connector, which is non-standard. Therefore, the antenna meets the requirement of Section 15.203. Furthermore, the product is installed by the metering company and once installed is no longer accessible to users.

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

7.2.1 Measurement Procedure

The EUT is battery operated therefore the evaluation of the power line conducted emissions is not applicable.

7.2.2 Radiated Spurious Emissions – FCC: 15.205, 15.209; ISED Canada RSS-247, RSS-Gen 8.9/8.10

7.2.2.1 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.

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.

The EUT was caused to generate a continuous modulated carrier on the hopping channel. The radiated spurious emissions were evaluated based on the worst case data rate determined in the original certification filing.

7.2.2.2 Duty Cycle Correction

The Duty Cycle Correction was not required.

7.2.2.3 Measurement Results

Table 7.2.2.3-1: Radiated Spurious Emissions – FHSS 2.6kbps

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 = 912.3 MHz										
991.28		22.40	H	25.54	-----	47.94	-----	54.0	-----	6.1
991.28		18.80	V	25.54	-----	44.34	-----	54.0	-----	9.7
976.3		18.40	H	24.74	-----	43.14	-----	54.0	-----	10.9
976.3		15.80	V	24.74	-----	40.54	-----	54.0	-----	13.5
2736.93	49.60	47.10	H	-2.37	47.23	44.73	74.0	54.0	26.8	9.3
2736.93	53.20	51.50	V	-2.37	50.83	49.13	74.0	54.0	23.2	4.9
3649.24	46.10	41.90	H	1.05	47.15	42.95	74.0	54.0	26.8	11.0
3649.24	49.90	47.30	V	1.05	50.95	48.35	74.0	54.0	23.0	5.6
4561.55	44.20	38.50	H	3.54	47.74	42.04	74.0	54.0	26.3	12.0
4561.55	48.90	45.70	V	3.54	52.44	49.24	74.0	54.0	21.6	4.8
7298.48	39.90	29.70	H	7.55	47.45	37.25	74.0	54.0	26.5	16.7
7298.48	41.70	33.90	V	7.55	49.25	41.45	74.0	54.0	24.7	12.5
Middle Channel = 919.5 MHz										
983.52		17.60	H	25.18	-----	42.78	-----	54.0	-----	11.2
983.52		15.70	V	25.18	-----	40.88	-----	54.0	-----	13.1
2758.53	45.80	41.50	H	-2.31	43.49	39.19	74.0	54.0	30.5	14.8
2758.53	47.10	43.70	V	-2.31	44.79	41.39	74.0	54.0	29.2	12.6
3678.04	48.80	45.90	H	1.14	49.94	47.04	74.0	54.0	24.1	7.0
3678.04	50.50	48.50	V	1.14	51.64	49.64	74.0	54.0	22.4	4.4
4597.55	49.30	46.20	H	3.53	52.83	49.73	74.0	54.0	21.2	4.3
4597.55	51.80	49.50	V	3.53	55.33	53.03	74.0	54.0	18.7	1.0
7356.08	40.60	32.50	H	7.85	48.45	40.35	74.0	54.0	25.5	13.6
7356.08	42.10	35.50	V	7.85	49.95	43.35	74.0	54.0	24.0	10.6
High Channel = 927.01 MHz										
2781.03	48.50	45.40	H	-2.25	46.25	43.15	74.0	54.0	27.7	10.8
2781.03	50.70	47.90	V	-2.25	48.45	45.65	74.0	54.0	25.5	8.3
3708.04	45.60	37.30	H	1.23	46.83	38.53	74.0	54.0	27.2	15.5
3708.04	45.50	36.90	V	1.23	46.73	38.13	74.0	54.0	27.3	15.9
4635.05	42.20	34.40	H	3.52	45.72	37.92	74.0	54.0	28.3	16.1
4635.05	49.60	44.00	V	3.52	53.12	47.52	74.0	54.0	20.9	6.5
7416.08	43.70	31.10	H	8.16	51.86	39.26	74.0	54.0	22.1	14.7
7416.08	43.90	32.30	V	8.16	52.06	40.46	74.0	54.0	21.9	13.5

7.2.2.4 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: $49.60 - 2.37 = 47.23$ dBuV/mMargin: $74\text{dBuV/m} - 47.23\text{dBuV/m} = 26.77\text{dB}$

Example Calculation: Average

Corrected Level: $47.10 - 2.37 - 0 = 44.73$ dBuVMargin: $54\text{dBuV} - 44.73\text{dBuV} = 9.27\text{dB}$

8 CONCLUSION

In the opinion of TÜV SÜD America Inc. the MINODE-WATER4 / EchoShore-DX, manufactured by Mueller Systems, LLC 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