



Excellence in Compliance Testing

Certification Test Report

**FCC ID: Z9O-FAS1543-02
IC: 10060A-FAS154302**

**FCC Rule Part: 15.231
ISED Canada Radio Standards Specification: RSS-210**

ACS Report Number: 16-2065.W06.2A

Manufacturer: Ecolab Inc.
Model(s): FAS1543-02

Test Begin Date: **November 14, 2016**
Test End Date: **December 6, 2016**

Report Issue Date: February 6, 2017



FOR THE SCOPE OF ACCREDITATION UNDER CERTIFICATE NUMBER AT-1533

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 18 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-210.

1.2 Manufacturer Information

Ecolab, Inc.
370 Wabasha St N
St. Paul, MN 55102

1.3 Product description

The Ecolab Inc. model FAS1543-02 is an installation and maintenance tool for the Patient Safeguard System (PSS) which is a wireless hand hygiene reminder system used in a healthcare facility. The device includes three distinct transceivers operating at 125 kHz, 433.9 MHz and 2.4 GHz, respectively. This test report documents the compliance of the 433.9 MHz radio.

Technical Details

Frequency of Operation: 433.9 MHz
Number of Channels: 1
Modulation: FSK
Data Rate: 250 kbps
Antenna / Gain: Helical Antenna, 1.9 dBi
Input Voltage: 3 VDC (Size AA battery)

Test Sample Serial Number(s): ACS #6

Test Sample Condition: The device was provided in good operating condition without any noticeable physical defects.

1.4 Test Methodology and Considerations

The EUT was evaluated for radiated emissions for the 433.9 MHz transmitter in multiple orientations. The EUT was tested standalone per the manufacturer as of typical use. The peripheral test port is only active in the peripheral test and 125 kHz TX modes and is not loaded in the other modes of operation. The RF output power setting of the device was not configurable and was not provided for the evaluation. The timing parameters were measured via RF coupling to a spectrum analyzer using a near field probe. The device is battery operated only without any provision for connection to the AC mains. The device is exempted from the power line conducted emissions requirements.

The 125 kHz transmitter does not transmit simultaneously with the 433 MHz and 2405 MHz co-located transmitters. The evaluation for intermodulation products was only performed for the 433 MHz and 2405 MHz radios transmitting simultaneously. All intermodulation products were found to be in compliance to the requirements of FCC Section 15.209 and ISED Canada RSS-Gen. The evaluation of the 125 kHz and 2405 MHz transceivers as well as the assessment to the unintentional emissions requirements are documented in separate test reports.

2 TEST FACILITIES

2.1 Location

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

Advanced Compliance Solutions, Inc.
3998 FAU Blvd, Suite 310
Boca Raton, Florida 33431
Phone: (561) 961-5585
Fax: (561) 961-5587
www.acstestlab.com

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-1533 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.

FCC Test Firm Registration #: 475089
ISED Canada Lab Code: 4175C

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:

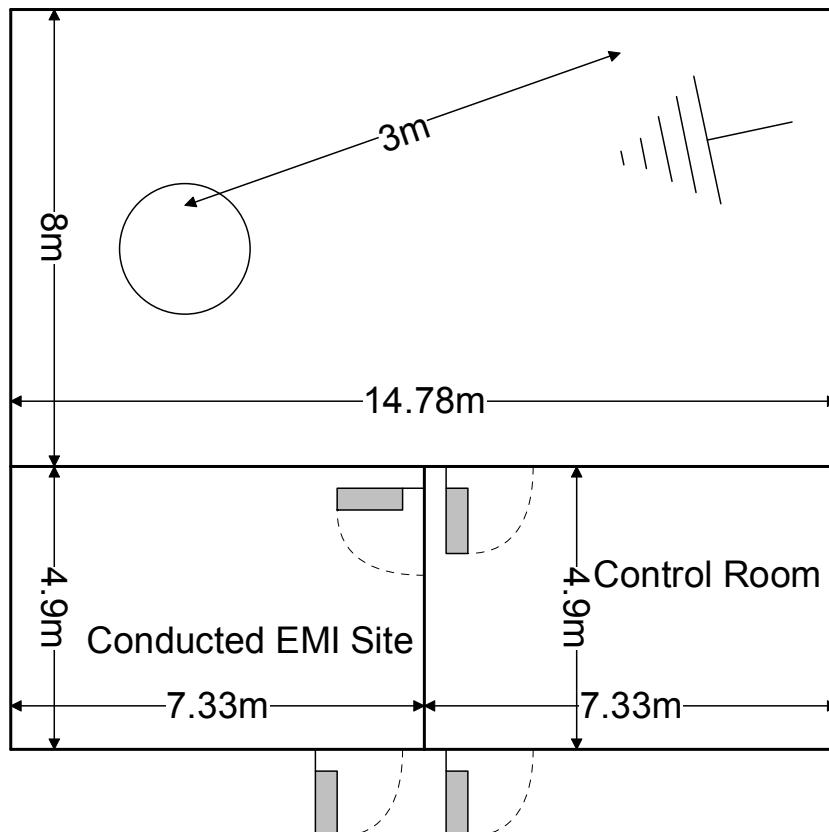


Figure 2.3.1-1: Semi-Anechoic Chamber Test Site

2.3.2 Conducted Emissions Test Site Description

The dimensions of the shielded conducted room are 7.3 x 4.9 x 3 m³. 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:

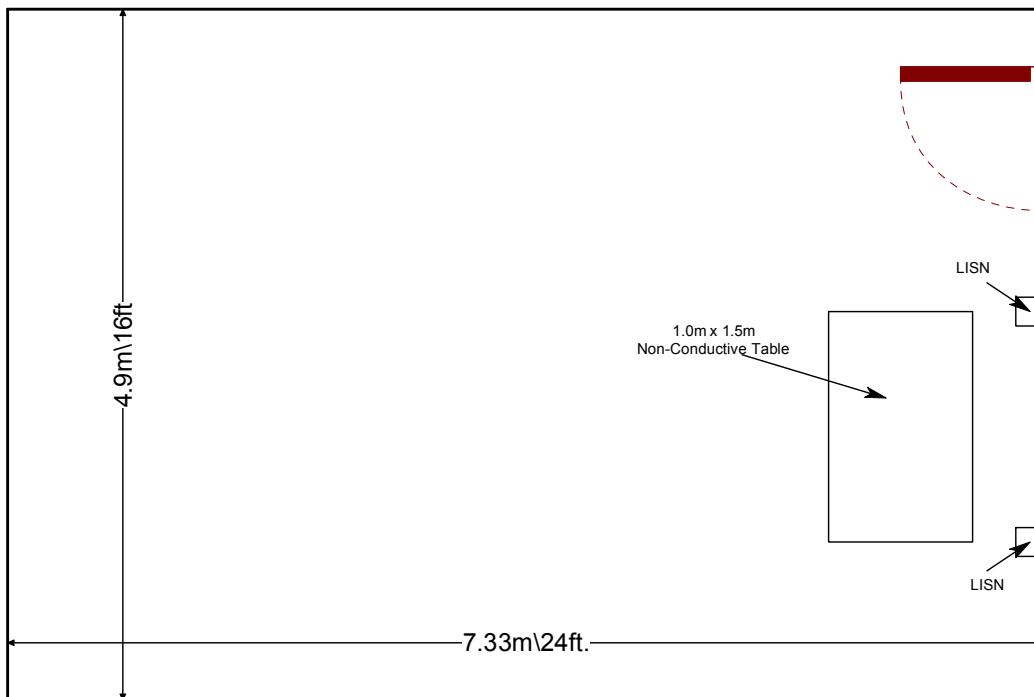


Figure 2.3.2-1: AC Mains Conducted EMI Site

3 APPLICABLE STANDARD REFERENCES

The following standards were used:

- ❖ ANSI C63.10-2013: 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
- ❖ Innovation, Science and Economic Development Canada Radio Standards Specification: RSS-GEN – General Requirements for Compliance of Radio Apparatus, Issue 4, November 2014.
- ❖ Innovation, Science and Economic Development Canada Radio Standards Specification: RSS-210 - Licence-Exempt Radio Apparatus: Category I Equipment, Issue 9 August 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
78	EMCO	6502	Antennas	9104-2608	5/11/2016	5/11/2018
523	Agilent	E7405	Spectrum Analyzers	MY45103293	12/26/2014	12/26/2016
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
2073	Mini Circuits	NHP-800	Filter	10247	11/17/2015	11/17/2016
2073	Mini Circuits	NHP-800	Filter	10247	12/1/2016	12/1/2017
2086	Merrimac	FAN-6-10K	Attenuators	23148-83-1	11/2/2016	11/2/2017
2089	Agilent Technologies, Inc.	83017A	Amplifiers	3123A00214	12/9/2015	12/9/2016
2094	Mini Circuits	SHP-1000+	Filter	R UU27401137	3/25/2016	3/25/2017
2095	ETS Lindgren	TILE4! - Version 4.2.A	Software	85242	NCR	NCR
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

Notes:

- **NCR=No Calibration Required**
- **The assets calibration cycle information is provided to cover the entire test period. The assets were only used during the active period of the calibration cycle.**

5 SUPPORT EQUIPMENT

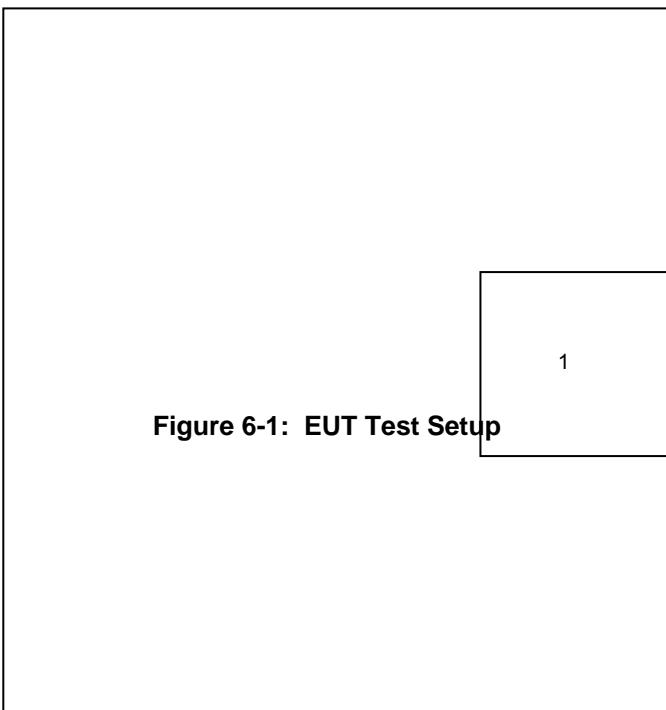
Table 5-1: EUT and Support Equipment

Item #	Type Device	Manufacturer	Model/Part #	Serial #
1	EUT	Ecolab Inc.	FAS1543-02	ACS#6

Table 5-2: Cable Description

Cable #	Cable Type	Length	Shield	Termination
	The device was tested standalone as the peripheral test connector is not active in the 433.9 MHz configuration			

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

For the 433.9 MHz radio, EUT uses an internal 1.9 dBi helical antenna that is directly soldered to the PCB. The antenna is not removable and meets the FCC 15.203 requirements.

7.2 20dB / 99% Bandwidth: FCC: Section 15.231(c); ISED Canada: RSS-210.A.1.3

7.2.1 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.

The RBW was set from 1% to 5% of the estimated emission bandwidth. The trace was set to max hold with a peak detector active. The Delta function of the analyzer was utilized to determine the 20 dB bandwidth of the emission.

The 99% occupied bandwidth was measured with the spectrum analyzer span set to fully display the emission, including the emissions skirts using a peak detector. The RBW was set from 1% and 5% of the estimated bandwidth. The occupied 99% bandwidth was measured by using a delta marker at the lower and upper frequencies leading to 0.5% of the total power with a sample detector.

7.2.2 Measurement Results

0.25% of the 433.164 MHz center frequency is equivalent to 1.08 MHz. Therefore the 20 dB and 99% bandwidths of the emission are less than 0.25% of the center frequency.

Results are shown below in Table 7.2.2-1 and Figures 7.2.2-1 through 7.2.2-2

Table 7.2.2-1: 20dB / 99% Bandwidth

Frequency [MHz]	20dB Bandwidth [kHz]	99% Bandwidth [kHz]
433.9	522.036	516.909

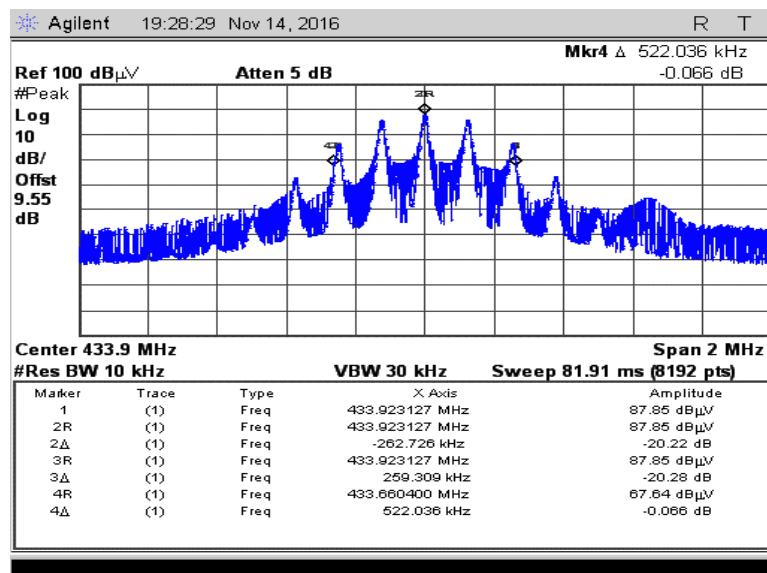


Figure 7.2.2-1: 20dB BW

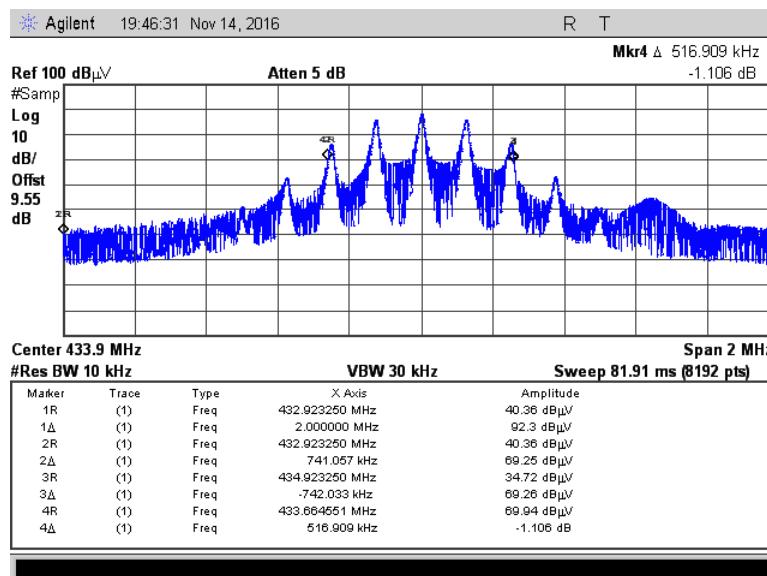


Figure 7.2.2-2: 99% OBW

7.3 Radiated Spurious Emissions – FCC: Section 15.231(b); ISED Canada: RSS-210 A.1.2

7.3.1 Measurement Procedure

Radiated emissions tests were made over the frequency range of 9 kHz to 4.5 GHz, 10 times the highest fundamental frequency.

Measurements below 30 MHz were performed in a semi-anechoic chamber with a 3 meter separation distance between the EUT and measurement antenna. The EUT was rotated 360 to maximize each emission. The magnetic loop receiving antenna was positioned with its lowest point 1 meter above the ground. The loop antenna was aligned along the site axis, orthogonal to the site axis, and ground-parallel to the site axis.

The spectrum analyzer's resolution and video bandwidths were set to 200 Hz and 1000 Hz respectively for frequencies below 150 kHz and 9 kHz and 30 kHz respectively for frequencies above 150 kHz and below 30 MHz.

For measurements above 30MHz, 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, measurements were made using a resolution bandwidth (RBW) of 120 kHz and a video bandwidth (VBW) of 300 kHz. For frequencies above 1000MHz, measurements were made with RBW of 1 MHz and a VBW of 3 MHz.

An average detector was used for all measurement. The peak emissions were also compared to a limit corresponding to 20 dB above the maximum permitted average limit according to Part 15.35. The final measurements were then corrected by antenna correction factors and cable loss for comparison to the limits. Further, compliance with the provisions of 15.205 was demonstrated using the measurement instrumentation specified in that section where applicable.”

7.3.2 Duty Cycle Correction

A Duty Cycle Correction of 1.312% corresponding to -37.64 dB was applied to the average measurements for the corrected average results. The justification of the duty cycle is provided in the equipment's theory of operation document.

7.3.3 Measurement Results

Radiated spurious emissions found in the band of 9 kHz to 4.5 GHz are reported in Tables 7.3.3-1 through 7.3.3-3: below.

Table 7.3.3-1: Radiated Spurious Emissions Tabulated Data – EUT Side

Frequency (MHz)	Level (dBuV)		Antenna Polarity (H/V)	Correction Factors (dB)	Corrected Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
	pk	avg			pk	avg	pk	avg	pk	avg
Fundamental Frequency										
433.92	88.46	88.21	H	-9.60	78.86	40.97	100.8	80.8	21.9	39.8
433.92	90.00	89.75	V	-9.60	80.40	42.51	100.8	80.8	20.4	38.3
Spurious Emissions										
312	43.78	38.17	H	-11.18	32.60	-10.65	80.8	60.8	48.2	71.5
867.84	31.85	25.93	H	-0.92	30.93	-12.63	80.8	60.8	49.9	73.4
867.84	36.55	32.22	V	-0.92	35.63	-6.34	80.8	60.8	45.2	67.1
1301.76	55.73	48.97	H	-11.59	44.14	-0.26	74	54	29.9	54.3
1301.76	60.32	55.27	V	-11.59	48.73	6.04	74	54	25.3	48.0
1735.68	50.72	38.74	H	-8.32	42.40	-7.22	80.8	60.8	38.4	68.0
1735.68	51.28	40.18	V	-8.32	42.96	-5.78	80.8	60.8	37.8	66.6
2169.6	57.95	50.18	H	-5.90	52.05	6.64	80.8	60.8	28.7	54.2
2169.6	58.34	50.96	V	-5.90	52.44	7.42	80.8	60.8	28.4	53.4
2603.52	48.62	36.42	H	-3.72	44.90	-4.94	80.8	60.8	35.9	65.7
2603.52	49.06	36.98	V	-3.72	45.34	-4.38	80.8	60.8	35.5	65.2
3037.44	48.11	36.30	H	-0.97	47.14	-2.31	80.8	60.8	33.7	63.1
3037.44	49.83	39.20	V	-0.97	48.86	0.59	80.8	60.8	31.9	60.2
3471.36	44.21	31.27	H	1.07	45.28	-5.30	80.8	60.8	35.5	66.1
3471.36	44.46	31.30	V	1.07	45.53	-5.27	80.8	60.8	35.3	66.1
3905.28	45.25	32.72	H	2.56	47.81	-2.36	74	54	26.2	56.4
3905.28	45.26	32.45	V	2.56	47.82	-2.63	74	54	26.2	56.6
4339.2	43.75	30.22	H	2.67	46.42	-4.76	74	54	27.6	58.8

Notes:

- The fundamental emissions were measured using RBW = 1 MHz which is greater than the measured occupied bandwidth.
- A duty cycle correction factor of -37.64 dB was applied to the average measurements for the spurious emissions.

Table 7.3.3-2: Radiated Spurious Emissions Tabulated Data – EUT Standing

Frequency (MHz)	Level (dBuV)		Antenna Polarity (H/V)	Correction Factors (dB)	Corrected Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
	pk	avg			pk	avg	pk	avg	pk	avg
Fundamental Frequency										
433.92	89.69	89.45	H	-9.60	80.09	42.21	100.8	80.8	20.7	38.6
433.92	91.23	91.04	V	-9.60	81.63	43.80	100.8	80.8	19.2	37.0
Spurious Emissions										
867.84	37.34	33.44	H	-0.92	36.42	-5.12	80.8	60.8	44.4	65.9
867.84	31.65	24.10	V	-0.92	30.73	-14.46	80.8	60.8	50.1	75.3
1301.76	59.74	54.96	H	-11.59	48.15	5.73	74	54	25.8	48.3
1301.76	56.90	50.98	V	-11.59	45.31	1.75	74	54	28.7	52.2
1735.68	49.77	37.54	H	-8.32	41.45	-8.42	80.8	60.8	39.4	69.2
1735.68	50.52	39.22	V	-8.32	42.20	-6.74	80.8	60.8	38.6	67.5
2169.6	57.13	49.39	H	-5.90	51.23	5.85	80.8	60.8	29.6	54.9
2169.6	53.46	44.55	V	-5.90	47.56	1.01	80.8	60.8	33.2	59.8
2603.52	47.54	35.16	H	-3.72	43.82	-6.20	80.8	60.8	37.0	67.0
2603.52	48.40	35.84	V	-3.72	44.68	-5.52	80.8	60.8	36.1	66.3
3037.44	50.97	40.28	H	-0.97	50.00	1.67	80.8	60.8	30.8	59.1
3037.44	47.14	34.91	V	-0.97	46.17	-3.70	80.8	60.8	34.6	64.5
3471.36	44.39	31.54	H	1.07	45.46	-5.03	80.8	60.8	35.3	65.8
3905.28	45.82	33.43	H	2.56	48.38	-1.65	74	54	25.6	55.7
3905.28	44.38	31.47	V	2.56	46.94	-3.61	74	54	27.1	57.6
4339.2	43.16	30.14	H	2.67	45.83	-4.84	74	54	28.2	58.8

Notes:

- The fundamental emissions were measured using RBW = 1 MHz which is greater than the measured occupied bandwidth.
- A duty cycle correction factor of -37.64 dB was applied to the average measurements for the spurious emissions.

Table 7.3.3-3: Radiated Spurious Emissions Tabulated Data – EUT Flat

Frequency (MHz)	Level (dBuV)		Antenna Polarity (H/V)	Correction Factors (dB)	Corrected Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
	pk	avg			pk	avg	pk	avg	pk	avg
Fundamental Frequency										
433.92	91.64	91.39	H	-9.60	82.04	44.15	100.8	80.8	18.8	36.7
433.92	84.28	83.88	V	-9.60	74.68	36.64	100.8	80.8	26.1	44.2
Spurious Emissions										
312.5	44.04	38.92	H	-11.22	32.82	-9.95	80.8	60.8	48.0	70.7
400.235	44.85	30.95	H	-10.66	34.19	-17.35	66	46	31.8	63.4
867.84	37.71	33.53	H	-0.92	36.79	-5.03	80.8	60.8	44.0	65.8
867.84	32.75	25.83	V	-0.92	31.83	-12.73	80.8	60.8	49.0	73.5
1301.76	57.89	52.91	H	-11.59	46.30	3.68	74	54	27.7	50.3
1301.76	56.20	49.94	V	-11.59	44.61	0.71	74	54	29.4	53.3
1735.68	51.00	41.19	H	-8.32	42.68	-4.77	80.8	60.8	38.1	65.6
1735.68	48.75	36.52	V	-8.32	40.43	-9.44	80.8	60.8	40.4	70.2
2169.6	58.68	51.35	H	-5.90	52.78	7.81	80.8	60.8	28.0	53.0
2169.6	57.68	50.57	V	-5.90	51.78	7.03	80.8	60.8	29.0	53.8
2603.52	48.64	36.96	H	-3.72	44.92	-4.40	80.8	60.8	35.9	65.2
2603.52	47.87	35.31	V	-3.72	44.15	-6.05	80.8	60.8	36.7	66.9
3037.44	50.08	39.84	H	-0.97	49.11	1.23	80.8	60.8	31.7	59.6
3037.44	49.19	38.26	V	-0.97	48.22	-0.35	80.8	60.8	32.6	61.2
3471.36	44.11	30.99	V	1.07	45.18	-5.58	80.8	60.8	35.6	66.4
3905.28	44.13	31.42	H	2.56	46.69	-3.66	74	54	27.3	57.7
3905.28	46.41	34.36	V	2.56	48.97	-0.72	74	54	25.0	54.7
4339.2	43.10	30.19	V	2.67	45.77	-4.79	74	54	28.2	58.8

Notes:

- The fundamental emissions were measured using RBW = 1 MHz which is greater than the measured occupied bandwidth.
- A duty cycle correction factor of -37.64 dB was applied to the average measurements for the spurious emissions.

7.3.4 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

$$\text{Corrected Level: } 55.73 + (-11.59) = 44.14 \text{ dB}\mu\text{V/m}$$

$$\text{Margin: } 74 \text{ dB}\mu\text{V/m} - 44.14 \text{ dB}\mu\text{V/m} = 29.9 \text{ dB}$$

Example Calculation: Average

$$\text{Corrected Level: } 48.97 + (-11.59) - 37.64 = -0.26 \text{ dB}\mu\text{V/m}$$

$$\text{Margin: } 54 \text{ dB}\mu\text{V} - (-0.26) \text{ dB}\mu\text{V/m} = 54.3 \text{ dB}$$

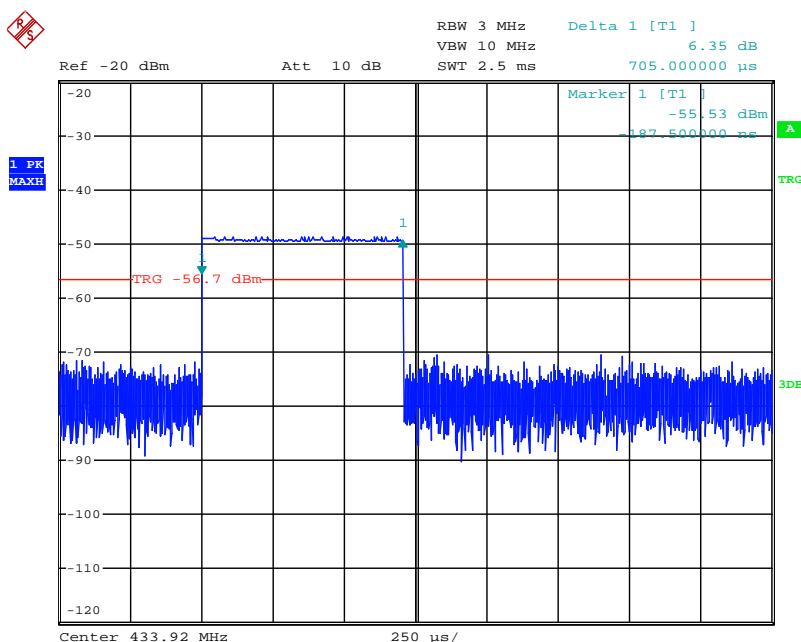
7.4 Periodic Operation – FCC: CFR 47 15.231(a); ISED Canada: RSS-210 A.1.1

7.4.1 Test Methodology

A manually operated transmitter shall employ a switch that will automatically deactivate the transmitter within not more than 5 seconds of being released. A transmitter activated automatically shall cease transmission within 5 seconds after activation. The transmitter was activated automatically and was evaluated using a spectrum analyzer at zero span.

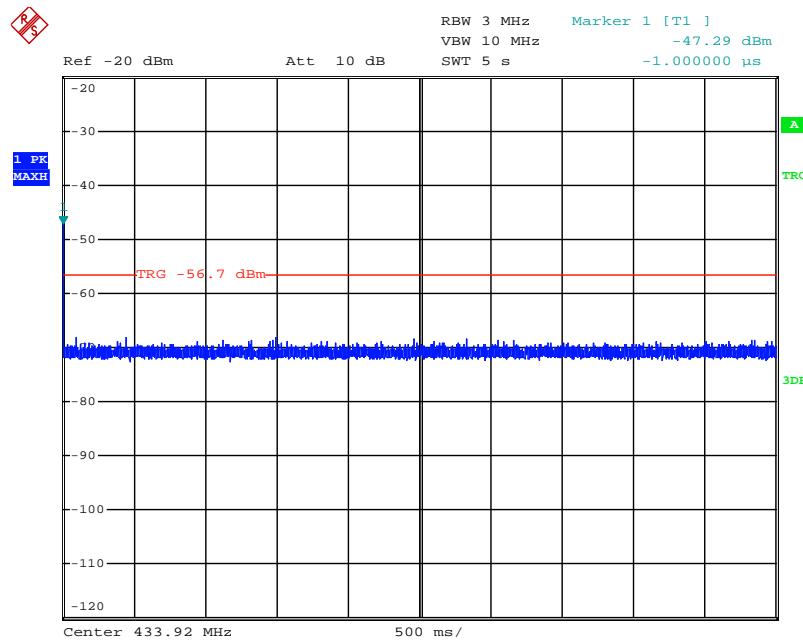
7.4.2 Test Results

The results are shown below.



Date: 6.DEC.2016 17:13:18

Figure 7.4.2-1: Periodic Operation – 2.5 Milliseconds



Date: 6.DEC.2016 17:08:07

Figure 7.4.2-2: Periodic Operation – 5 Seconds

8 CONCLUSION

In the opinion of ACS, Inc. the model FAS1543-02, manufactured by Ecolab Inc. meets the requirements of FCC Part 15 subpart C and Innovation, Science and Economic Development Canada's Radio Standards Specification RSS-210.

END REPORT