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Certification Test Report

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

**FCC Rule Part: 15.209
ISED Canada Radio Standards Specification: RSS-210**

ACS Report Number: 16-2065.W06.1A

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 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 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 125 kHz radio.

Technical Details

Frequency of Operation: 125.8 kHz
Number of Channels: 1
Modulation: OOK
Data Rate: 1.2 kbps
Antenna: Magnetic Loop Antenna
Input Voltage: 3 VDC (Size AA Battery)

Test Sample Serial Number(s): ACS#3

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 125 kHz transmitter in multiple orientations. The side orientation was deemed the worst case and is reported in this document. The device was tested standalone (internal antenna) as well as with the external loop antenna FAS1540 connected to the peripheral test port. The results are reported for both configurations. The RF output power setting of the device was not configurable and was not provided for the evaluation.

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 433 MHz and 2405 MHz transceivers as well as the assessment to the unintentional emissions requirements are documented in separate test reports.

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.

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:

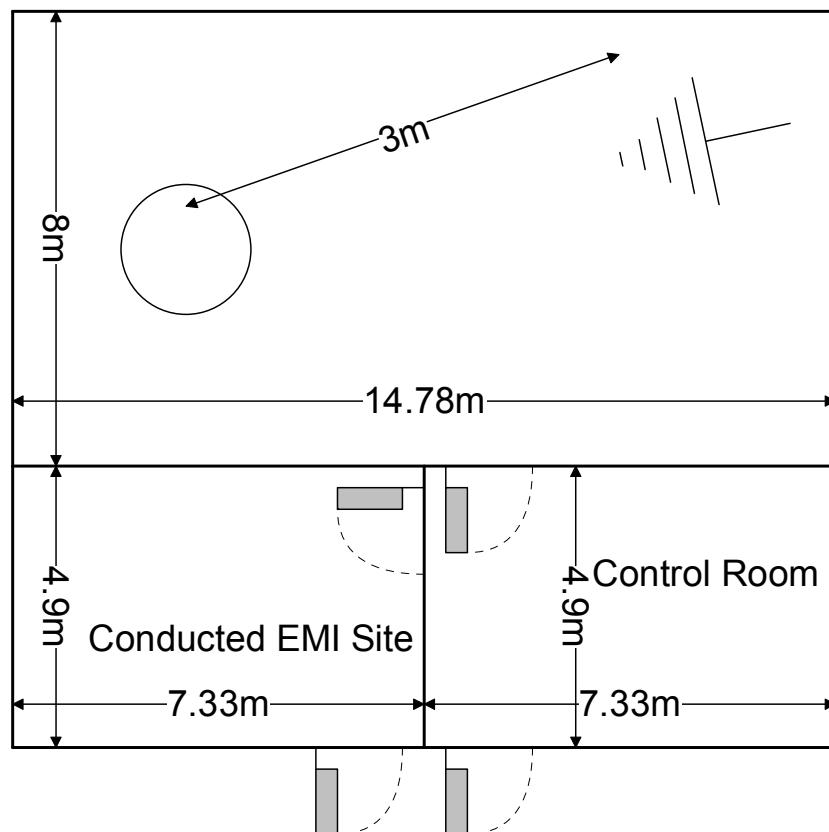


Figure 2.3.1-1: Semi-Anechoic Chamber Test Site

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:

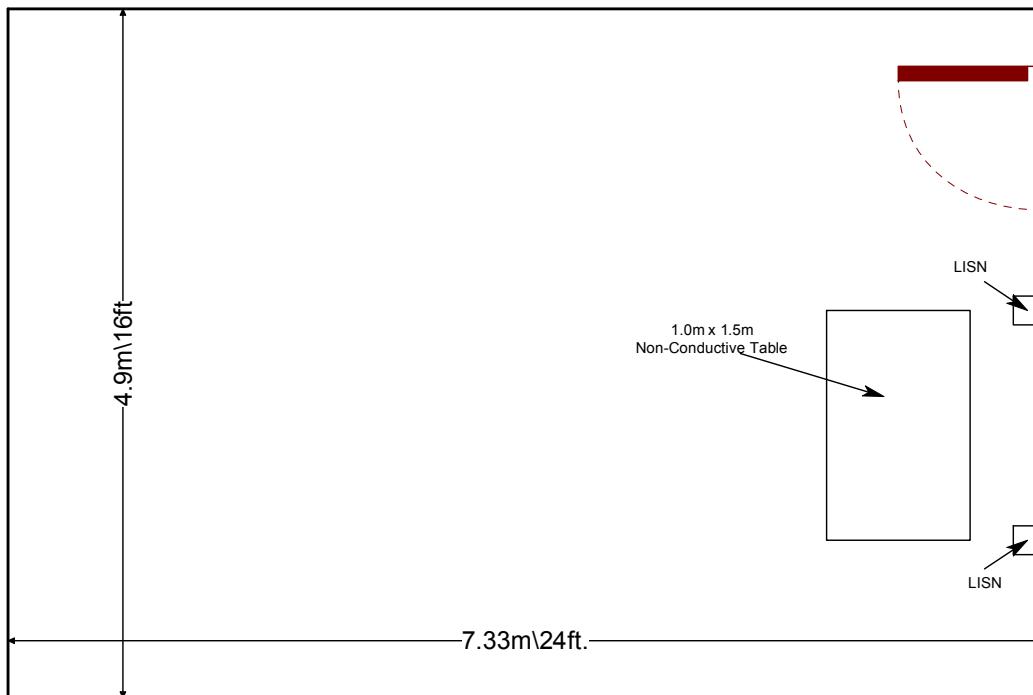


Figure 2.3.2-1: AC Mains Conducted EMI Site

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
2011	Hewlett-Packard	HP 8447D	Amplifiers	2443A03952	11/2/2016	11/2/2017
2095	ETS Lindgren	TILE4! - Version 4.2.A	Software	85242	NCR	NCR
2121	ACS Boca	Radiated Cable Set	Cable Set	2121	8/1/2016	8/1/2017

NCR=No Calibration Required

5 SUPPORT EQUIPMENT

Table 5-1: EUT and Support Equipment

Item #	Type Device	Manufacturer	Model/Part #	Serial #
1	EUT	Ecolab Inc.	FAS1543-02	ACS#3
2	Loop Antenna	Ecolab Inc.	FAS1540	ACS#8

Table 5-2: Cable Description

Cable #	Cable Type	Length	Shield	Termination
A	RJ25	1.22m	No	Antenna to EUT

6 EQUIPMENT UNDER TEST SETUP BLOCK DIAGRAM

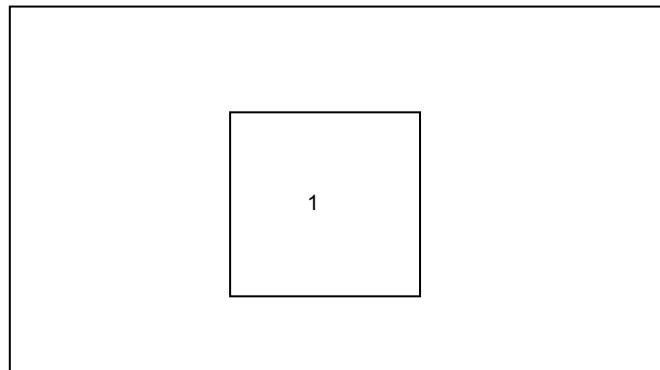


Figure 6-1: EUT Test Setup (Standalone)

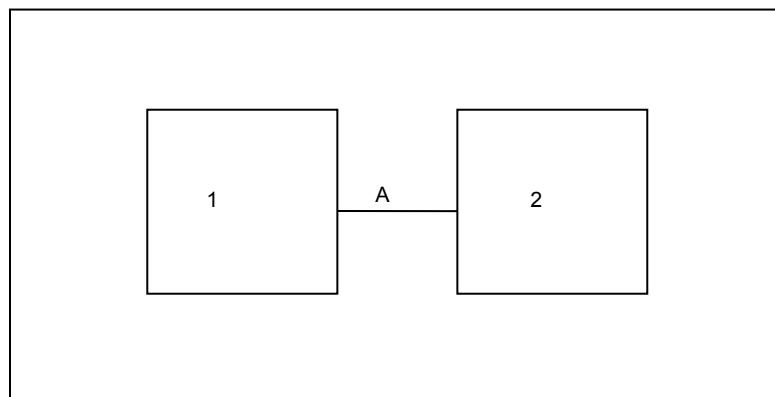


Figure 6-2: EUT Test Setup (External Antenna)

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 125 kHz radio, EUT uses an internal loop antenna that is directly soldered to the PCB. The unit can also be configured with the external FAS1540 antenna which uses an RJ25 connector. Both configurations meet the FCC 15.203 requirements.

7.2 20dB / 99% Bandwidth: FCC: Section 15.215; ISED Canada: RSS-Gen 6.6

7.2.1 Measurement Procedure

The spectrum analyzer span was set to 2 to 5 times the estimated bandwidth of the emission. 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.

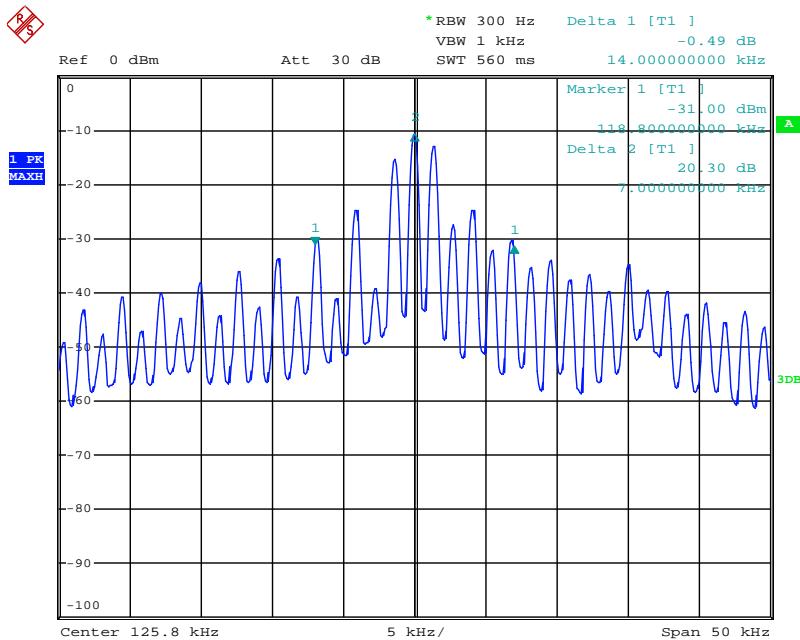
The 99% occupied bandwidth was measured with the spectrum analyzer span set to fully display the emission, including the emissions skirts. The RBW was set from 1% to 5% of the estimated 99% bandwidth. The occupied 99% bandwidth was measured by using the 99% BW function of the spectrum analyzer with a sample detector.

7.2.2 Measurement Results

Results are shown below:

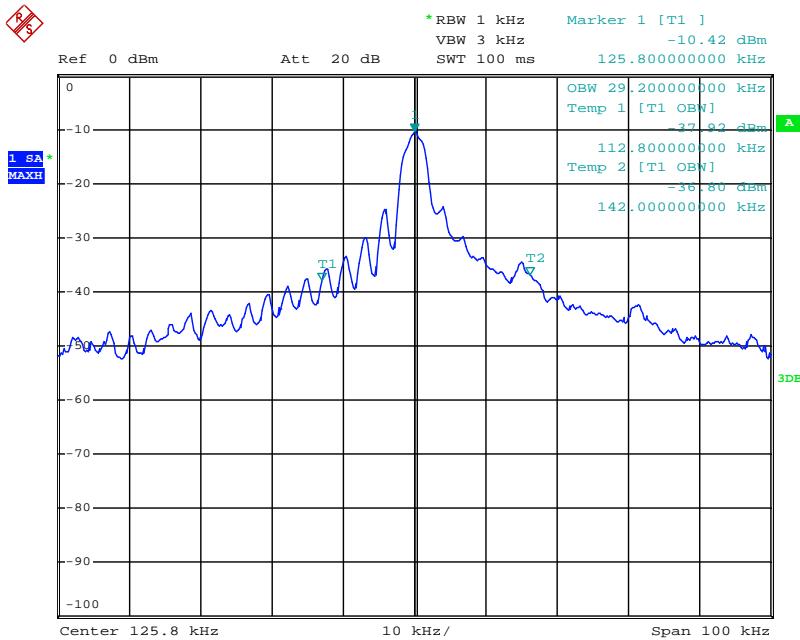
Table 7.2.2-1: 20dB / 99% Bandwidth

Frequency [MHz]	20dB Bandwidth [kHz]	99% Bandwidth [kHz]
0.1258	14.0	29.2



Date: 18.NOV.2016 12:59:58

Figure 7.2.2-1: 20dB BW



Date: 18.NOV.2016 12:53:50

Figure 7.2.2-2: 99% OBW

7.3 Radiated Spurious Emissions – FCC: Section 15.209; ISED Canada: RSS-210 2.5

7.3.1 Measurement Procedure

Radiated emissions tests were made over the frequency range of 9 kHz to 1 GHz. Section 15.33(a)(4) specifies, if the intentional radiator contains a digital device, regardless of whether this digital device controls the functions of the intentional radiator or the digital device is used for additional control or function purposes other than to enable the operation of the intentional radiator, the frequency range shall be investigated up to frequency specified in 15.33(b)(1) for unintentional radiators. The upper frequency range for the digital device is 1000MHz which is greater than the 10th harmonic of the fundamental frequency. The upper frequency range measured was 1000 MHz.

Measurements below 30 MHz were performed in a semi-anechoic chamber with a 3 meter separation distance between the EUT and measurement antenna. The magnetic loop receiving antenna was positioned 1 meter above the ground. The EUT was rotated 360° to maximize each emission. The spectrum analyzer's resolution and video bandwidths were set to 200 Hz and 1000 Hz respectively for frequencies below 150 kHz, and to 9 kHz and 30 kHz respectively for frequencies between 150 kHz and 30 MHz. The fundamental levels were measured using a resolution bandwidth of 30 kHz which is greater than the measured emission bandwidth. For measurements in the frequency bands 9-90 kHz and 110-490 kHz, an average detector was used. When average measurements are specified, the peak emissions were also compared to a limit corresponding to 20 dB above the maximum permitted average limit according to Part 15.35. All other emissions were measured using a Quasi-peak detector. The final measurements were then corrected by antenna correction factors and cable loss for comparison to the limits.

Measurements above 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 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 resolution bandwidth (RBW) of 120 kHz and a video bandwidth (VBW) of 300 kHz.

7.3.2 Distance Correction for Measurements below 30 MHz – FCC: Section 15.31

Radiated measurements were performed at a distance closer than 300 meters and 30m as required, according to Part 15.209. Therefore a correction factor was applied to account for propagation loss at the specified distance. The propagation loss was determined by using the square of an inverse linear distance extrapolation factor (40dB/decade) according to 15.31. A sample calculation of the distance correction factor is shown below for limits expressed at a 300m measurement distance and a 30m measurement distance.

$$\begin{aligned}\text{Distance correction factor (300m Specified Test Distance)} &= 40 \cdot \log(\text{Test Distance}/300) \\ &= 40 \cdot \log(3/300) \\ &= -80 \text{ dB}\end{aligned}$$

$$\begin{aligned}\text{Distance correction factor (30m Specified Test Distance)} &= 40 \cdot \log(\text{Test Distance}/30) \\ &= 40 \cdot \log(3/30) \\ &= -40 \text{ dB}\end{aligned}$$

7.3.3 Measurement Results

Radiated spurious emissions found in the band of 9 kHz to 1 GHz are reported in the Table below.

Table 7.3.3-1: Radiated Spurious Emissions Tabulated Data – Standalone

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										
0.1258	69.72	61.04	H	10.40	80.12	71.44	125.6	105.6	45.5	34.2
0.1258	65.68	56.48	V	10.40	76.08	66.88	125.6	105.6	49.5	38.7

Notes:

- The fundamental level was measured using RBW = 30 kHz which is greater than the measured occupied bandwidth.
- The distance correction factor per Section 7.3.2 of this document was applied to the limits below 30 MHz.
- All the spurious emissions within the range of evaluation were attenuated below the limits and the measurement equipment noise floor.

Table 7.3.3-2: Radiated Spurious Emissions Tabulated Data – External Loop Antenna

Frequency (MHz)	Level (dBuV)		Antenna Polarity (H/V)	Correction Factors (dB)	Corrected Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
	pk	QP/Avg			pk	QP/Avg	pk	QP/Avg	pk	QP/Avg
Fundamental Frequency										
0.1258	69.45	61.86	H	10.40	79.85	72.26	125.6	105.6	45.7	33.3
0.1258	63.77	54.62	V	10.40	74.17	65.02	125.6	105.6	51.4	40.6
Spurious Emissions										
66.6149	-----	51.22	H	-18.08	-----	33.14	-----	40	-----	6.9
70.3757	-----	51.41	H	-18.37	-----	33.05	-----	40	-----	7.0
70.97	-----	54.31	H	-18.42	-----	35.89	-----	40	-----	4.1
78.6843	-----	45.87	H	-18.95	-----	26.93	-----	40	-----	13.1
110.988	-----	41.29	V	-16.18	-----	25.10	-----	43.5	-----	18.4
110.999	-----	47.82	H	-16.18	-----	31.64	-----	43.5	-----	11.9
122.561	-----	45.20	H	-14.91	-----	30.29	-----	43.5	-----	13.2
147.924	-----	38.61	H	-13.91	-----	24.70	-----	43.5	-----	18.8
159.623	-----	39.40	H	-13.55	-----	25.85	-----	43.5	-----	17.6
162.152	-----	38.38	H	-13.51	-----	24.87	-----	43.5	-----	18.6
199.744	-----	43.35	H	-12.33	-----	31.02	-----	43.5	-----	12.5
996.375	-----	22.35	V	0.47	-----	22.81	-----	54	-----	31.2
998.593	-----	22.20	H	0.54	-----	22.75	-----	54	-----	31.3

Notes:

- The fundamental level Peak and Average measurements used RBW = 30 kHz which is greater than the measured occupied bandwidth.
- The distance correction factor per Section 7.3.2 of this document was applied to the limits below 30 MHz.
- All the spurious emissions between 9 kHz to 30 MHz were attenuated below the limits and the measurement equipment noise floor.
- Quasi-Peak measurements were performed for the emissions above 30 MHz.

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

Corrected Level: $69.72 + 10.4 = 80.12 \text{ dB}\mu\text{V/m}$

Margin: $125.6 \text{ dB}\mu\text{V/m} - 80.12 \text{ dB}\mu\text{V/m} = 45.5 \text{ dB}$

Example Calculation: Average

Corrected Level: $61.04 + 10.4 - 0 = 71.44 \text{ dB}\mu\text{V/m}$

Margin: $105.6 \text{ dB}\mu\text{V/m} - 71.44 \text{ dB}\mu\text{V/m} = 34.2 \text{ dB}$

8 CONCLUSION

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

END REPORT