Certification Test Report

FCC ID: X32-NSHKG020
IC: 8797A-NSHKG020

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

Report Number: AT72128703.1C1

Manufacturer: iKeyless, LLC
Model: NSHKL-G02X

Test Begin Date: August 10, 2017
Test End Date: August 20, 2017

Report Issue Date: November 29, 2017

For Scope of Accreditation Under Certificate Number: AT-2021

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

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This report contains 17 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 for certification.

1.2 Product description

The NSHKL-G02X is a 315MHz, ASK modulation, remote keyless entry FOB.

Technical Information:

Detail	Description
Frequency Range	315 MHz
Number of Channels	1
Modulation Format	ASK
Operating Voltage	3 Vdc (CR1620 coin cell)
Antenna Type / Gain	Loop Antenna / -18dBi

Manufacturer Information:
iKeyless, LLC
828 E. Market St.
Louisville, KY 40206

Test Sample Serial Number(s): #1 (Continuous Mode), #2 (Normal Mode)

Test Sample Condition: The test sample was provided in working order with no visible defects.

1.3 Test Methodology and Considerations

All modes of operation, including all available data rates, were evaluated. The data presented in this report represents the worst case where applicable.

For Radiated Emissions, the EUT was programmed to generate a continuously modulated signal. The EUT was evaluated in three orthogonal orientations. See test setup photos for more information.

For RF bandwidth and timing parameter testing, the EUT was programmed for normal operation. The EUT was evaluated with a near field probe to facilitate coupling to the test equipment.

The EUT is a battery powered device with no provisions for connection to the public utilities, therefore power line conducted emissions was not performed.

Software power setting during test: 5dBm

2 TEST FACILITIES

2.1 Location

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

TÜV SÜD America Inc.
5015 B.U. Bowman Drive
Buford GA 30518
Phone: (770) 831-8048
Fax: (770) 831-8598
www.TUVamerica.com

2.2 Laboratory Accreditations/Recognitions/Certifications

TÜV SÜD America Inc. is accredited to ISO/IEC 17025 by the ANSI-ASQ National Accreditation Board/ANAB accreditation program, and has been issued certificate number AT-2021 in recognition of this accreditation. 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, ISED Canada and the Japanese Voluntary Control Council for Interference by information technology equipment.

FCC Registration Number: 391271
ISED Canada Lab Code: IC 4175A
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:

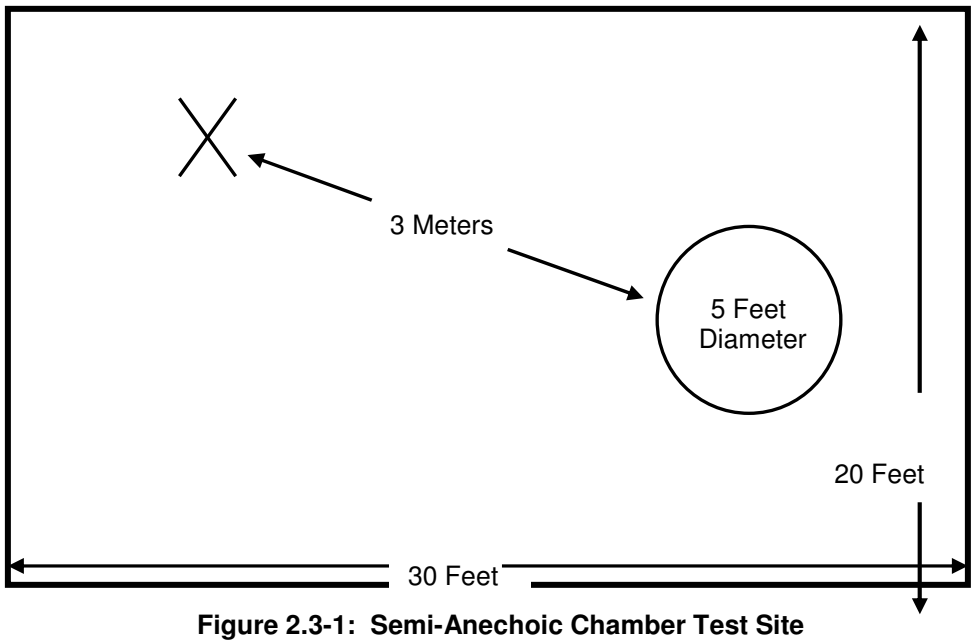

Figure 2.3-1: Semi-Anechoic Chamber Test Site

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:

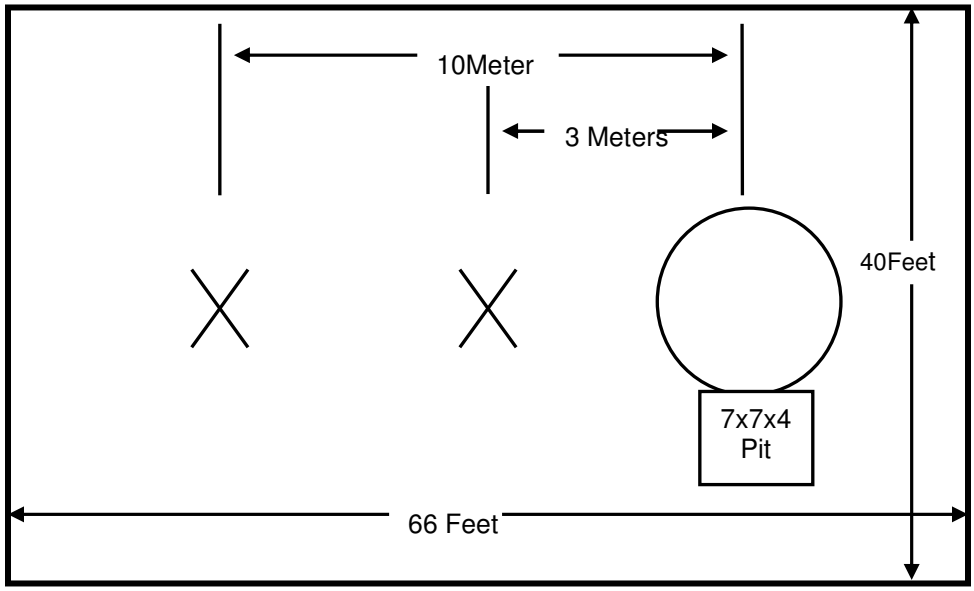

Figure 2.3-2: Open Area Test Site

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.

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

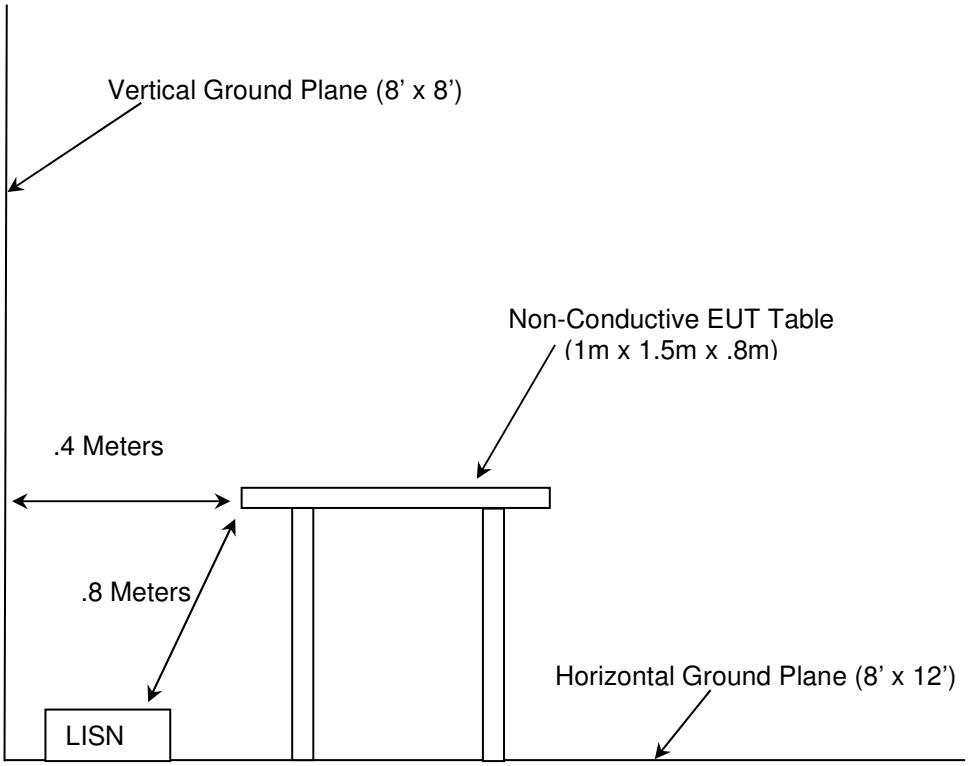

Figure 2.4-1: AC Mains Conducted EMI Site

3 APPLICABLE STANDARD REFERENCES

The following standards were used:

- ANSI C63.4-2014: American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz 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, 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-210 – Low-power License-exempt Radiocommunication Devices (All Frequency Bands): Category I Equipment, Issue 9, August 2016
- Innovation, Science and Economic Development 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

AssetID	Manufacturer	Model #	Equipment Type	Serial #	Last Calibration Date	Calibration Due Date
30	Spectrum Technologies	DRH-0118	Antennas	970102	5/9/2017	5/9/2019
40	EMCO	3104	Antennas	3211	6/8/2016	6/8/2018
73	Agilent	8447D	Amplifiers	2727A05624	7/24/2017	7/24/2018
167	ACS	Chamber EMI Cable Set	Cable Set	167	9/30/2016	9/30/2017
338	Hewlett Packard	8449B	Amplifiers	3008A01111	7/11/2017	7/11/2019
412	Electro Metrics	LPA-25	Antennas	1241	8/8/2016	8/8/2018
422	Florida RF	SMS-200AW-72.0-SMR	Cables	805	10/27/2016	10/27/2017
616	Florida RF Cables	SMRE-200W-12.0-SMRE	Cables	N/A	9/2/2016	9/2/2017
622	Rohde & Schwarz	FSV40	Analyzers	101338	7/15/2016	7/15/2018
628	EMCO	6502	Antennas	9407-2877	2/11/2016	2/11/2018
676	Florida RF Labs	SMS-290AW-480.0-SMS	Cables	MFR2Y194	11/4/2016	11/4/2017
RE135	Rohde & Schwarz	FSP30	Spectrum Analyzers	835618/031	10/31/2016	10/31/2017

5 SUPPORT EQUIPMENT

Table 5-1: Support Equipment

Item #	Type Device	Manufacturer	Model/Part #	Serial #
The EUT is a battery operated equipment therefore no ancillary or support equipment was utilized. The EUT was tested stand-alone.				

Table 5-2: Cable Description

Cable #	Cable Type	Length	Shield	Termination
The EUT is a battery operated equipment therefore no ancillary or support equipment was utilized. The EUT was tested stand-alone.				

6 EQUIPMENT UNDER TEST SETUP BLOCK DIAGRAM

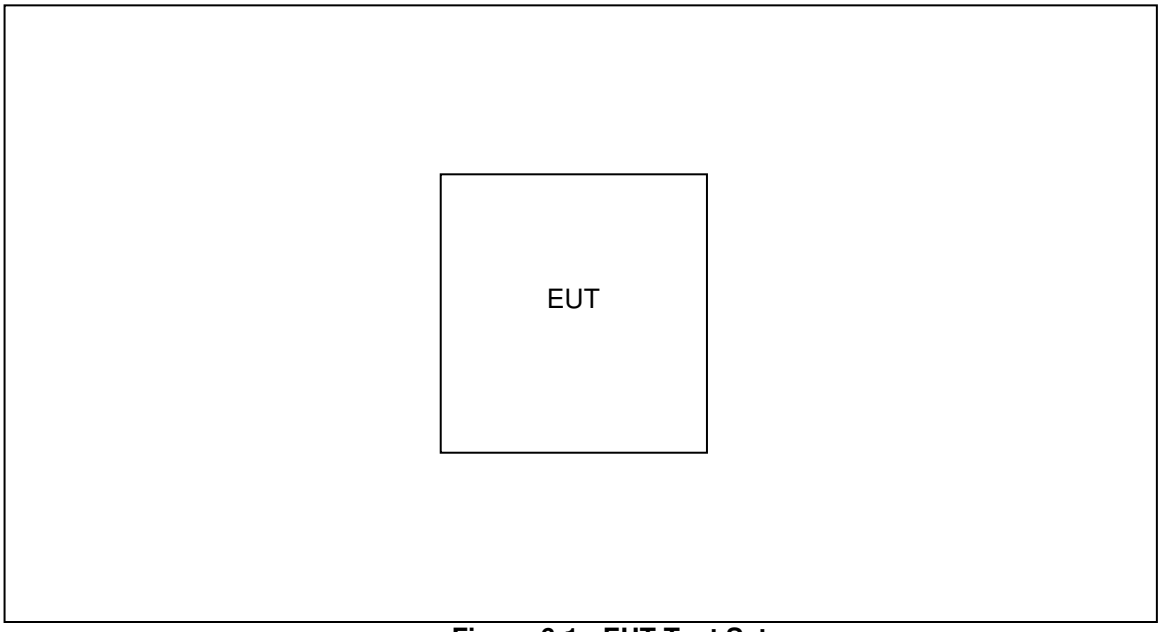

Figure 6-1: EUT Test Setup

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: Part 15.203

The antenna is a PCB Printed Loop antenna and is non-detachable without compromising the device, therefore satisfying Part 15.203. The antenna gain is -18dBi.

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

7.2.1 Measurement Procedure

The EUT is a battery powered device with no provisions for connection to the public utilities, therefore power line conducted emissions was not performed.

7.3 Periodic Operation – FCC: Part 15.231(a); ISED Canada: RSS-210 A.1.1

7.3.1 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 manually and was evaluated using a spectrum analyzer at zero span with a > 5 second sweep time.

7.3.2 Test Results

Performed by: Ryan McGann

The transmitter ceased operation 374.85 ms after being manually activated. The results are shown in Figure 7.3.2-1.

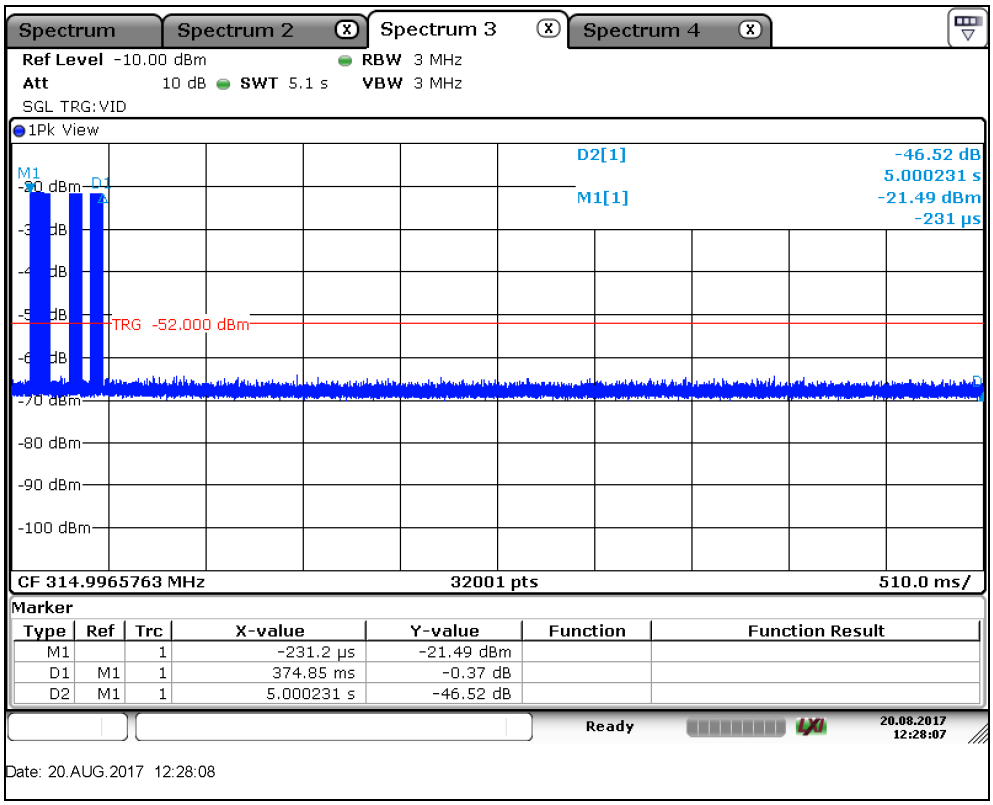

Figure 7.3.2-1: TX Hold Time

7.4 Occupied Bandwidth – FCC: Part 15.231(c); ISED Canada: RSS-210 A.1.3, RSS-GEN 6.6

7.4.1 Test Methodology

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 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 occupied bandwidth measurement function of the spectrum analyzer was used to measure the 99% bandwidth. The span of the analyzer was set to capture all products of the modulation process, including the emission sidebands. The resolution bandwidth was set to 1% to 5% of the occupied bandwidth. The video bandwidth was set to 3 times the resolution bandwidth. A peak detector was used.

7.4.2 Test Results

Performed by: Ryan McGann

0.25% of the 315 MHz center frequency is equivalent to 787.5 kHz. Therefore the 20 dB and 99% bandwidths of the emission are less than 0.25% of the center frequency. The results are shown in Table 7.4.2-1 and Figures 7.4.2-1 to 7.4.2-4.

Table 7.4.2-1: 20dB / 99% Bandwidth

Frequency [MHz]	20dB Bandwidth [kHz]	99% Bandwidth [kHz]
315	6.62	15.34

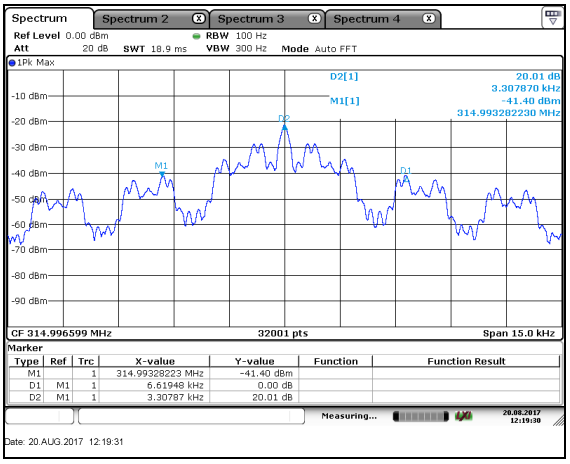

Figure 7.4.2-1: 20 dB Bandwidth

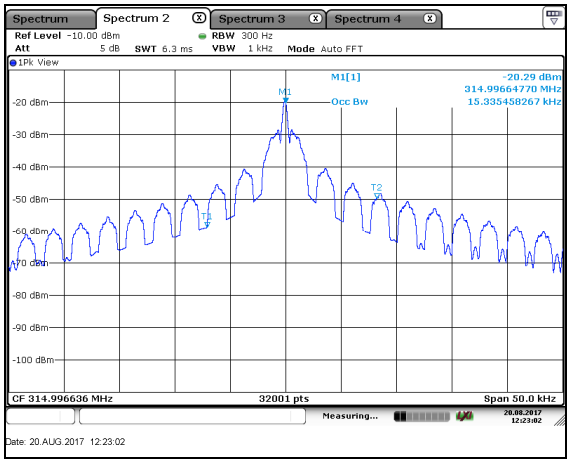

Figure 7.4.2-2: 99% Bandwidth

7.5 Radiated Emissions – FCC: Part 15.231(b); ISED Canada: RSS-210 A.1.2

7.5.1 Measurement Procedure

Radiated emissions tests were made over the frequency range of 9 kHz to 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 30 MHz, the EUT was rotated through 360° and the receive antenna height was varied from 1 meter to 4 meters so that the maximum radiated emissions level would be detected. For frequencies below 1000 MHz, measurements were made using a resolution bandwidth (RBW) of 120 kHz and a video bandwidth (VBW) of 300 kHz. For frequencies above 1000 MHz, measurements were made with RBW of 1 MHz and a VBW of 3 MHz.

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

7.5.2 Duty Cycle Correction

Performed by: Ryan McGann

For average radiated measurements, the measured level was reduced by a factor 9.082 dB to account for the duty cycle of the EUT. The worst case duty cycle was determined to be 35.149%. The duty cycle correction factor is determined using the formula: 20log (35.149/100) = -9.082 dB. Determination of the duty cycle correction is included in the plots and justification below.

Period (T) = 100 ms
Number Pulses (N1) = 84
Pulse Width (T1) = 0.418437 ms
(N1*T1)/T = ((84*0.418437) / 100 = 0.35149
20*Log(0.35149) = -9.082 dB Average Correction Factor

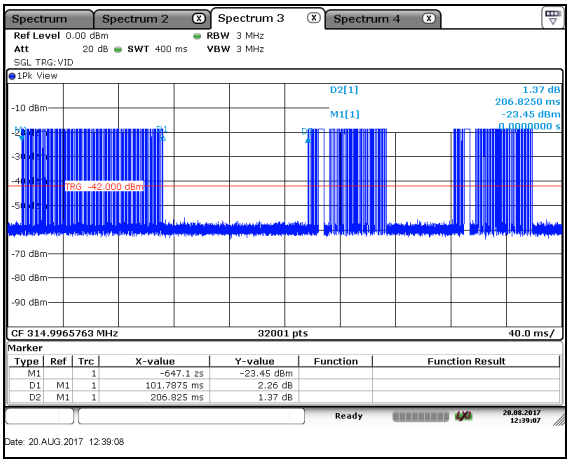

Figure 7.5.2-1: Duty Cycle

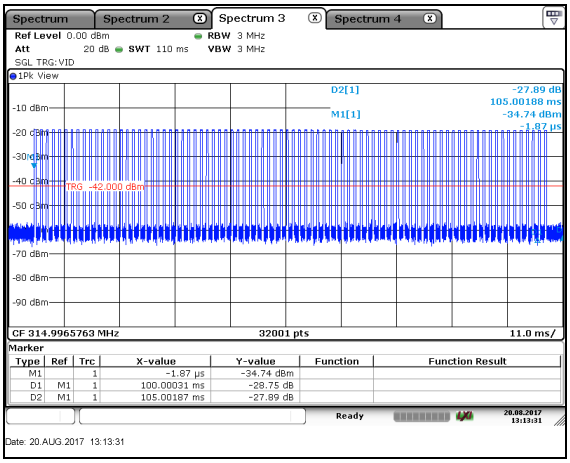

Figure 7.5.2-2: Duty Cycle

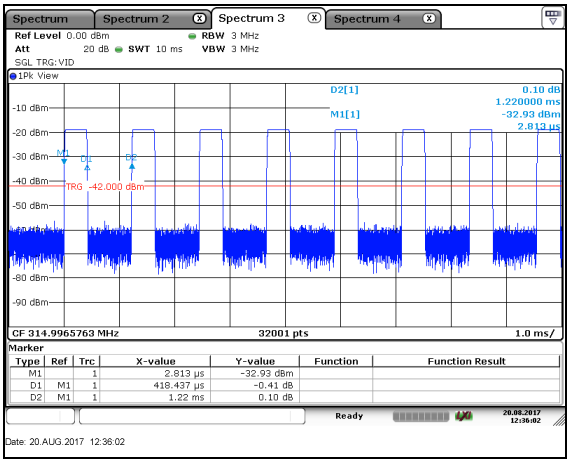

Figure 7.5.2-3: Duty Cycle – Pulse Width

7.5.3 Test Results

Performed by: Ryan McGann

Radiated spurious emissions are reported in Table 7.5.3-1 through Table 7.5.3-3. Emissions not reported were below the noise floor of the measurement system.

Table 7.5.3-1: Radiated Emissions – XPOS

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
Fundamental Emission										
315	86.44	86.44	H	-8.65	77.79	68.71	95.6	75.6	17.8	6.9
315	90.38	90.38	V	-8.65	81.73	72.65	95.6	75.6	13.9	3.0
Spurious Emissions										
630	40.86	40.86	H	-2.70	38.16	29.08	75.6	55.6	37.4	26.5
630	44.08	44.08	V	-2.70	41.38	32.30	75.6	55.6	34.2	23.3
945	36.98	36.98	H	2.25	39.23	30.15	75.6	55.6	36.4	25.5
945	34.13	34.13	V	2.25	36.38	27.30	75.6	55.6	39.2	28.3
1260	49.02	49.02	H	-11.71	37.31	28.23	75.6	55.6	38.3	27.4
1260	47.31	47.31	V	-11.71	35.60	26.52	75.6	55.6	40.0	29.1
1575	50.02	50.02	H	-9.89	40.13	31.05	74.0	54.0	33.9	22.9
1575	48.54	48.54	V	-9.89	38.65	29.57	74.0	54.0	35.3	24.4
1890	52.40	52.40	H	-7.85	44.55	35.46	75.6	55.6	31.1	20.2
1890	40.44	40.44	V	-7.85	32.59	23.50	75.6	55.6	43.0	32.1
2205	45.64	45.64	H	-6.28	39.36	30.28	74.0	54.0	34.6	23.7
2205	46.36	46.36	V	-6.28	40.08	31.00	74.0	54.0	33.9	23.0
2520	46.43	46.43	H	-4.97	41.46	32.38	75.6	55.6	34.1	23.2
2520	45.98	45.98	V	-4.97	41.01	31.93	75.6	55.6	34.6	23.7
2835	52.45	52.45	H	-3.99	48.46	39.38	74.0	54.0	25.5	14.6
2835	51.95	51.95	V	-3.99	47.96	38.88	74.0	54.0	26.0	15.1
3150	49.78	49.78	H	-2.99	46.79	37.71	75.6	55.6	28.8	17.9
3150	48.15	48.15	V	-2.99	45.16	36.08	75.6	55.6	30.4	19.5

Table 7.5.3-2: Radiated Emissions – YPOS

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
Fundamental Emission										
315	85.57	85.57	H	-8.65	76.92	67.84	95.6	75.6	18.7	7.8
315	90.87	90.87	V	-8.65	82.22	73.14	95.6	75.6	13.4	2.5
Spurious Emissions										
630	42.48	42.48	H	-2.70	39.78	30.70	75.6	55.6	35.8	24.9
630	41.86	41.86	V	-2.70	39.16	30.08	75.6	55.6	36.4	25.5
945	34.89	34.89	H	2.25	37.14	28.06	75.6	55.6	38.5	27.6
945	35.55	35.55	V	2.25	37.80	28.72	75.6	55.6	37.8	26.9
1260	48.55	48.55	H	-11.71	36.84	27.76	75.6	55.6	38.8	27.9
1260	51.21	51.21	V	-11.71	39.50	30.42	75.6	55.6	36.1	25.2
1575	47.97	47.97	H	-9.89	38.08	29.00	74.0	54.0	35.9	25.0
1575	49.40	49.40	V	-9.89	39.51	30.43	74.0	54.0	34.5	23.6
1890	48.01	48.01	H	-7.85	40.16	31.07	75.6	55.6	35.4	24.5
1890	53.05	53.05	V	-7.85	45.20	36.11	75.6	55.6	30.4	19.5
2205	46.53	46.53	H	-6.28	40.25	31.17	74.0	54.0	33.7	22.8
2205	46.01	46.01	V	-6.28	39.73	30.65	74.0	54.0	34.3	23.3
2520	47.52	47.52	H	-4.97	42.55	33.47	75.6	55.6	33.0	22.2
2520	46.13	46.13	V	-4.97	41.16	32.08	75.6	55.6	34.4	23.5
2835	53.65	53.65	H	-3.99	49.66	40.58	74.0	54.0	24.3	13.4
2835	50.75	50.75	V	-3.99	46.76	37.68	74.0	54.0	27.2	16.3
3150	49.53	49.73	H	-2.99	46.54	37.66	75.6	55.6	29.1	18.0
3150	48.86	48.86	V	-2.99	45.87	36.79	75.6	55.6	29.7	18.8

Table 7.5.3-3: Radiated Emissions – ZPOS

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
Fundamental Emission										
315	91.47	91.47	H	-8.65	82.82	73.74	95.6	75.6	12.8	1.9
315	72.24	72.24	V	-8.65	63.59	54.51	95.6	75.6	32.0	21.1
Spurious Emissions										
630	45.12	45.12	H	-2.70	42.42	33.34	75.6	55.6	33.2	22.3
630	38.33	38.33	V	-2.70	35.63	26.55	75.6	55.6	40.0	29.1
945	34.10	34.10	H	2.25	36.35	27.27	75.6	55.6	39.3	28.4
945	33.69	33.69	V	2.25	35.94	26.86	75.6	55.6	39.7	28.8
1260	48.61	48.61	H	-11.71	36.90	27.82	75.6	55.6	38.7	27.8
1260	47.51	47.51	V	-11.71	35.80	26.72	75.6	55.6	39.8	28.9
1575	49.44	49.44	H	-9.89	39.55	30.47	74.0	54.0	34.4	23.5
1575	48.85	48.85	V	-9.89	38.96	29.88	74.0	54.0	35.0	24.1
1890	49.71	49.71	H	-7.85	41.86	32.77	75.6	55.6	33.7	22.8
1890	47.46	47.46	V	-7.85	39.61	30.52	75.6	55.6	36.0	25.1
2205	46.72	46.72	H	-6.28	40.44	31.36	74.0	54.0	33.6	22.6
2205	47.91	47.91	V	-6.28	41.63	32.55	74.0	54.0	32.4	21.4
2520	46.44	46.44	H	-4.97	41.47	32.39	75.6	55.6	34.1	23.2
2520	47.54	47.54	V	-4.97	42.57	33.49	75.6	55.6	33.0	22.1
2835	50.81	50.81	H	-3.99	46.82	37.74	74.0	54.0	27.2	16.3
2835	48.33	48.33	V	-3.99	44.34	35.26	74.0	54.0	29.7	18.7
3150	48.80	48.80	H	-2.99	45.81	36.73	75.6	55.6	29.8	18.9
3150	49.66	49.66	V	-2.99	46.67	37.59	75.6	55.6	28.9	18.0

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 – Fundamental Frequency – XPOS
Corrected Level: 86.44 - 8.65 = 77.79dBuV
Margin: 95.6dBuV – 77.79dBuV = 17.8dB

Example Calculation: Average – Fundamental Frequency – XPOS
Corrected Level: 86.44 - 8.65 - 9.082 = 68.71dBuV
Margin: 75.6dBuV – 68.71dBuV = 6.9dB

8 ESTIMATION OF MEASUREMENT UNCERTAINTY

The expanded laboratory measurement uncertainty figures (U_{Lab}) provided below correspond to an expansion factor (coverage factor) k = 1.96 which provide confidence levels of 95%.

Table 8-1: Estimation of Measurement Uncertainty

Parameter	U_{lab}
Occupied Channel Bandwidth	± 0.009 %
RF Conducted Output Power	± 0.349 dB
Power Spectral Density	± 0.372 dB
Antenna Port Conducted Emissions	± 1.264 dB
Radiated Emissions ≤ 1 GHz	± 5.814 dB
Radiated Emissions > 1 GHz	± 4.318 dB
Temperature	± 0.860 °C
Radio Frequency	± 2.832 x 10^{-8}
AC Power Line Conducted Emissions	± 3.360 dB

9 CONCLUSION

In the opinion of TÜV SÜD America Inc. the NSHKL-G02X manufactured by iKeyless, LLC met the requirements of FCC Part 15 subpart C and Innovation, Science and Economic Development Canada's Radio Standards Specification RSS-210 for the tests documented herein.

END REPORT