Excellence in Compliance Testing

Certification Test Report

FCC ID: X32-1RHK
IC: 8797A-1RHK

FCC Rule Part: 15.231
IC Radio Standards Specification: RSS-210

ACS Report Number: 15-3021.W06.1B

Manufacturer: iKeyless, LLC
Model: 300-0403

Test Begin Date: May 18, 2015
Test End Date: May 26, 2015

Report Issue Date: July 30, 2015

ANAB ACCREDITED ISO/IEC 17025 TESTING LABORATORY

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.

Reviewed by:

M. R de Aranzeta

Mario de Aranzeta
Lab Manager Durham (RTP)
ACS Inc.

This report contains 21 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 300-0403 is an aftermarket replacement remote for the keyless entry systems of automobiles. The remote features a plastic shell with a rubber insert, user buttons, a microcontroller with integrated transmitter, key blade, and a CR1632 battery. Under normal operation, when a user presses one of the buttons, a keyless entry signal is transmitted as either an ASK or FSK modulation as outlined below. The keyless entry signal consists of packets of data that may include serial numbers, function codes, checksums, and authentication codes.

ASK (A1D) Remote Operation: 312.5 – 315.16 MHz (6 Channels)
FSK (F1D) Remote Operation: 313.83 MHz (100 kHz deviation) and 315 MHz (34 kHz deviation)
Operating Voltage: 3 VDC (CR1632 Battery)
Antenna Type / Gain: Loop / -13.7 dBi

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

Test Sample Serial Number(s): A, B

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

1.3 Test Methodology and Considerations

The EUT is a stand-alone handheld device and was tested in (3) orientations which represent normal intended operation.

The EUT is a battery powered device; therefore AC power line conducted emissions was not performed.

The EUT was evaluated for the modulations and frequencies identified below.
312.5 MHz (ASK Modulation Low Channel)
315.16 MHz (ASK Modulation High Channel)
313.83 MHz (FSK Modulation 100 kHz deviation)
315 MHz (FSK Modulation 34 kHz deviation)

2 TEST FACILITIES

2.1 Location

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

Advanced Compliance Solutions
2320 Presidential Drive, Suite 101
Durham, NC 27703
Phone: (919) 381-4235

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-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.

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.

To comply with the requirements of the test methods given on page 4, RF absorbing foam was placed inside the chamber in a configuration that provided the best results. First, a 12ft X 12ft. patch of 10" tall absorber was placed on the floor between the turntable and the receiving antenna. This absorber meets the absorption requirements specified in ANSI C63.4:2009.

A diagram of the Semi-Anechoic Chamber Test Site is shown in Figure 2.3-1 below:

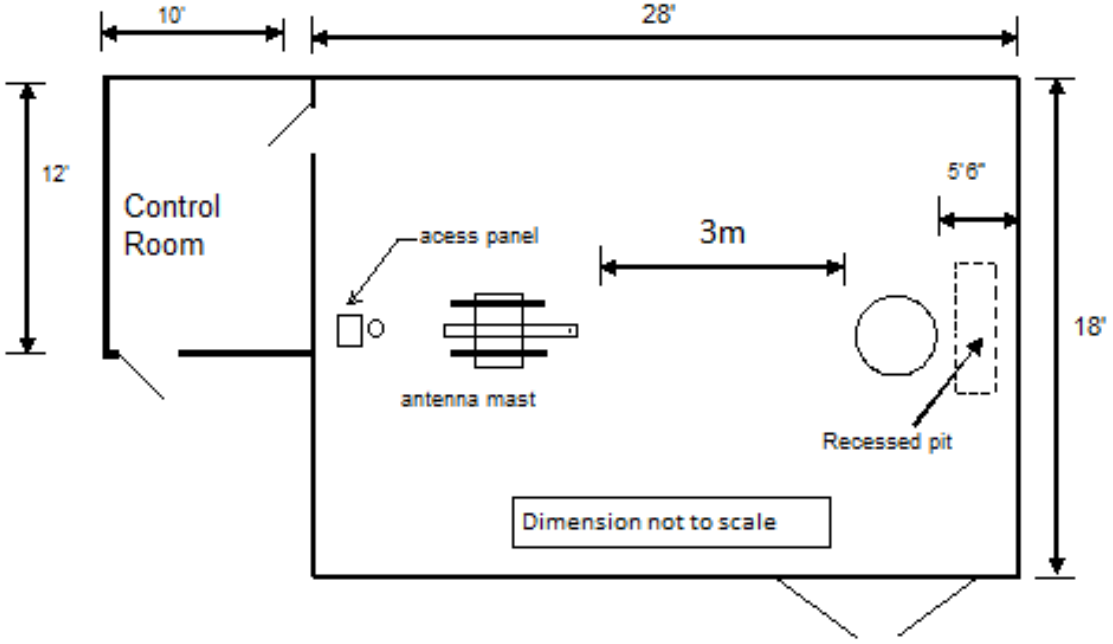

Figure 2.3-1: Semi-Anechoic Chamber Test Site

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:

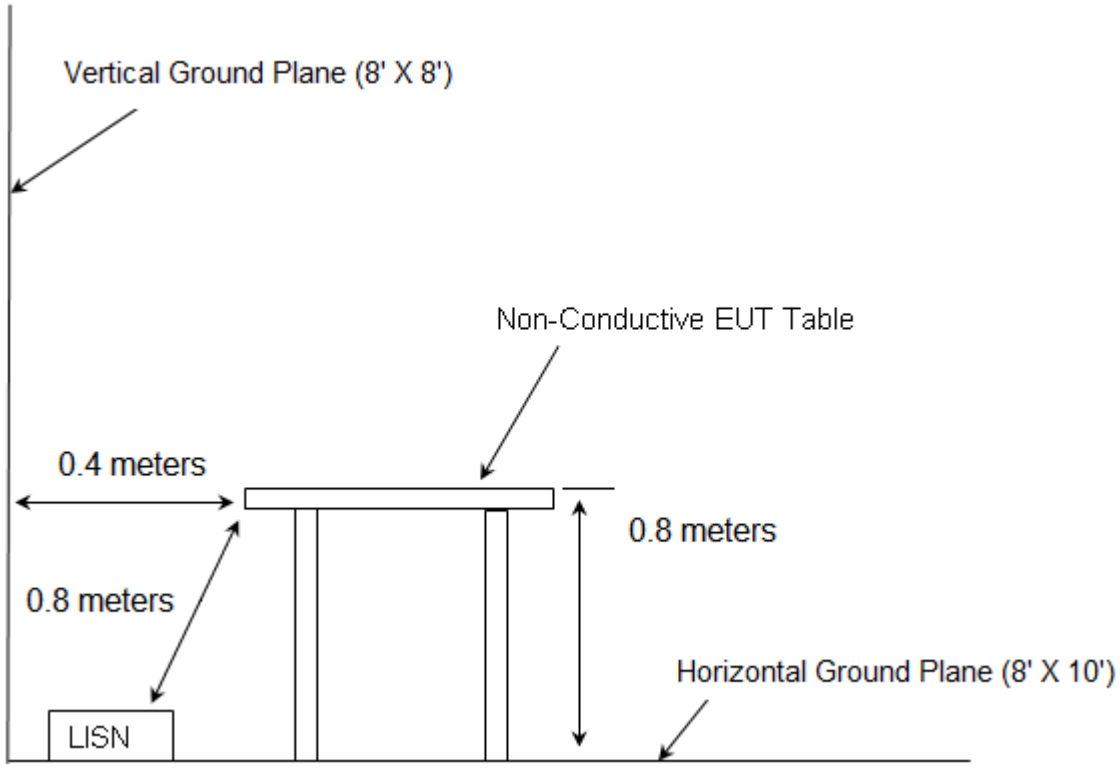

Figure 2.4-1: AC Mains Conducted EMI Site

3 APPLICABLE STANDARD REFERENCES

The following standards were used:

- ANSI C63.10-2009: American National Standard for Testing Unlicensed Wireless Devices
- 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, 2014
- US Code of Federal Regulations (CFR): Title 47, Part 15, Subpart C: Radio Frequency Devices, Intentional Radiators, 2014
- 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 for Compliance of Radio Apparatus, Issue 4, Nov 2014.

* For Industry Canada reference only.

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
3002	Rohde & Schwarz	ESU40	Receiver	100346	7/25/2014	7/25/2015
3038	Florida RF Labs	NMSE-290AW-60.0-NMSE	Cable Set	1448	1/12/2015	1/12/2016
3039	Florida RF Labs	NMSE-290AW-396.0-NMSE	Cable Set	1447	1/12/2015	1/12/2016
3016	Fei Teng Wireless Technology	HA-07M18G-NF	Antennas	2013120203	1/14/2015	1/14/2016
3057	Advanced Technical Materials	42-441-6/BR	Antennas	R110602	NCR	NCR
626	EMCO	3110B	Antennas	9411-1945	2/26/2014	2/26/2016
277	Emco	93146	Antennas	9904-5199	9/2/2014	9/2/2016
3006	Rohde & Schwarz	TS-PR18	Amplifiers	122006	7/24/2014	7/24/2015
3007	Rohde & Schwarz	TS-PR26	Amplifiers	100051	7/14/2014	7/14/2015
3054	Mountain View Cable	BMS-RG400-36.0-BMS	Cables	3054	1/12/2015	1/12/2016
3020	Rohde & Schwarz	SMB100A	Signal Generators	175943	7/24/2014	7/24/2015
3008	Rohde & Schwarz	NRP2	Meter	103131	1/15/2015	1/15/2016
3009	Rohde & Schwarz	NRP-Z81	Meter	102397	1/15/2015	1/15/2016
3046	Aeroflex Inmet	26AH-10	Attenuator	1443	1/15/2015	1/15/2016
3033	Hasco, Inc.	HLL142-S1-S1-36	Cables	1435	1/15/2015	1/15/2016
3034	Hasco, Inc.	HLL142-S1-S1-12	Cables	3076	1/18/2015	1/18/2016
3012	Rohde & Schwarz	EMC32-EB	Software	100731	1/19/2015	7/19/2016

NCR = No Calibration Required
Firmware Version: ESU40 is 4.73 SP1
Software Version: EMC32-B is 9.15

5 SUPPORT EQUIPMENT

Table 5-1: Support Equipment

Item #	Manufacturer	Equipment Type	Model Number	Serial Number
The EUT operates standalone therefore no support equipment was utilized.				

6 EQUIPMENT UNDER TEST SETUP BLOCK DIAGRAM

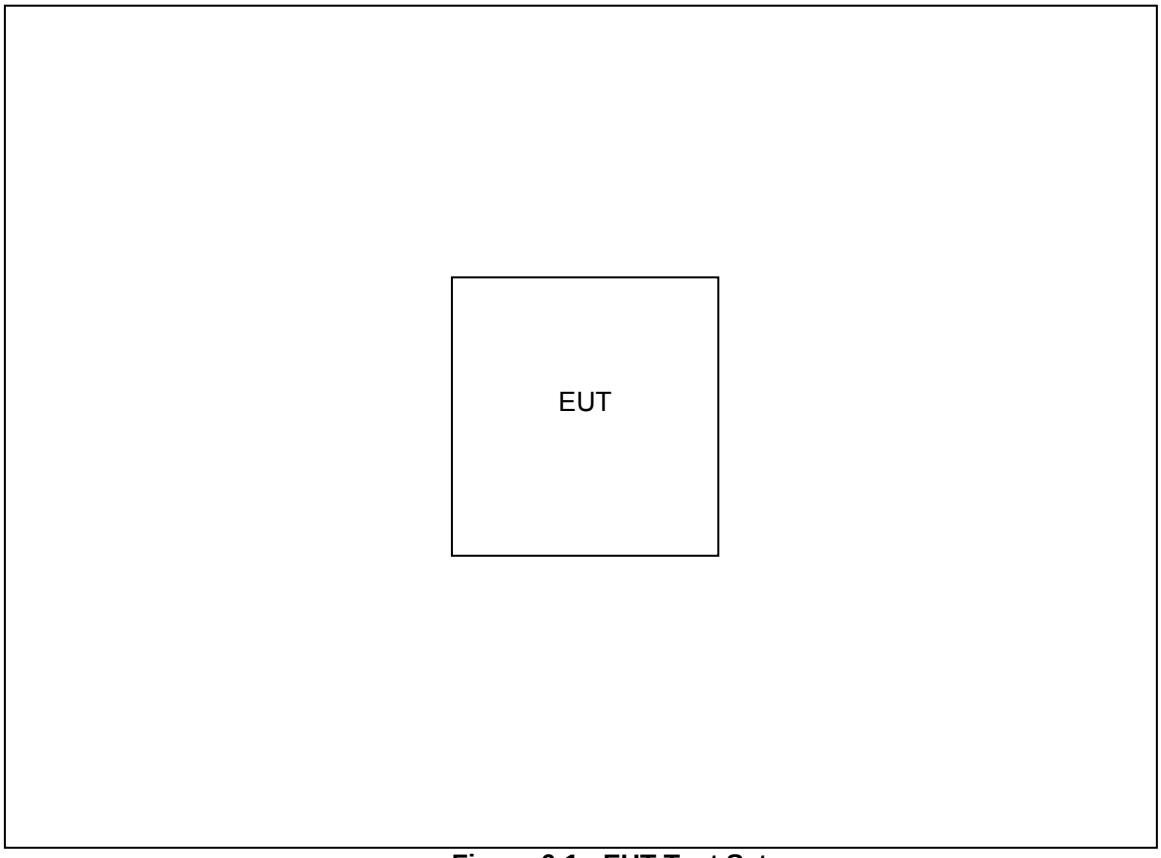

Figure 6-1: EUT Test Setup

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: CFR 47 Part 15.203

The antenna is a loop antenna that is implemented as a copper trace on the PCB, thus satisfying Part 15.203. The antenna gain is -13.7dBi.

7.2 Power Line Conducted Emissions – FCC: CFR 47 Part 15.207/ IC: RSS-GEN 8.8

7.2.1 Measurement Procedure

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

7.3 Periodic Operation – FCC: CFR 47 15.231(a) / IC: RSS-210 A1.1.1

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.

7.3.2 Test Results

The transmitter ceased operation after the next whole packet was sent after being manually activated and deactivated. The results are shown in Figure 7.3.2-1. At a maximum this would be 100ms over the last packet when deactivation occurs.

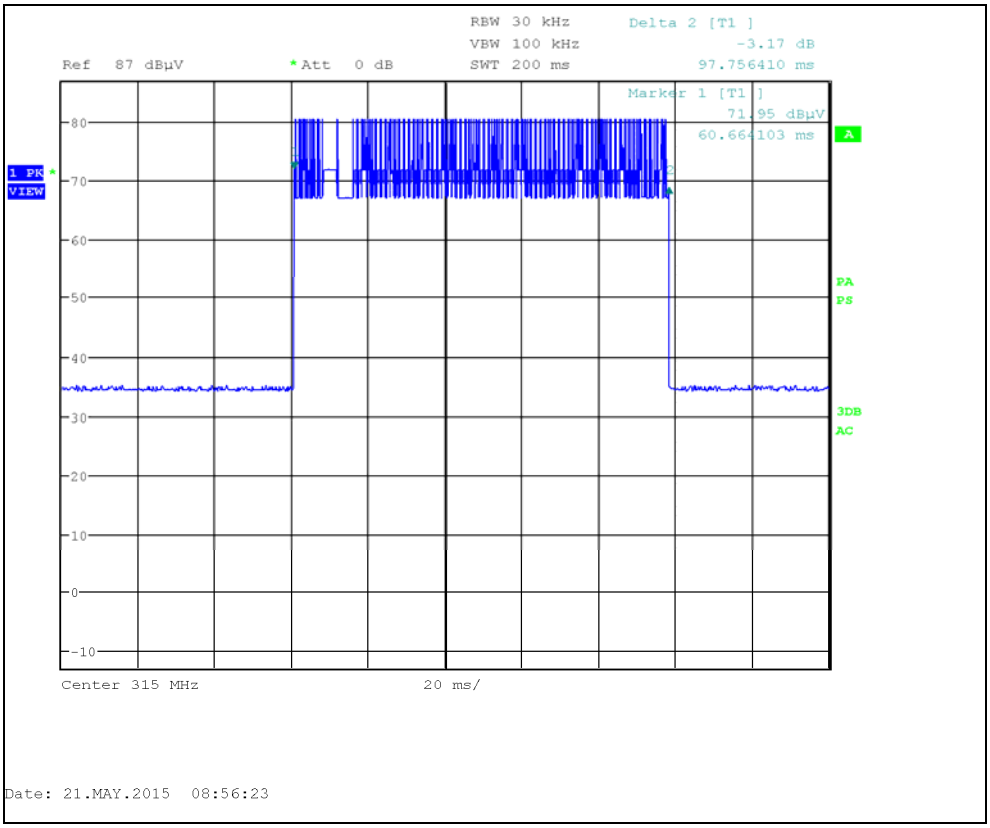

Figure 7.3.2-1: TX Hold Time

7.4 Occupied Bandwidth – FCC: CFR 47 15.231(c)(1) / IC: RSS-210 A1.1.3

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

0.25% of the 315 MHz center frequency is equivalent to 787.5 kHz. Therefore the 20 dB and 99% bandwidths of the emissions 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 and 7.4.2-6.

Table 7.4.2-1: 20dB / 99% Bandwidth

Modulation	Frequency [MHz]	20dB Bandwidth [kHz]	99% Bandwidth [kHz]
FSK (34 kHz Deviation)	315.16	84.13	80.93
FSK (100 kHz Deviation)	313.83	213.14	213.14
ASK	312.5	6.09	13.78

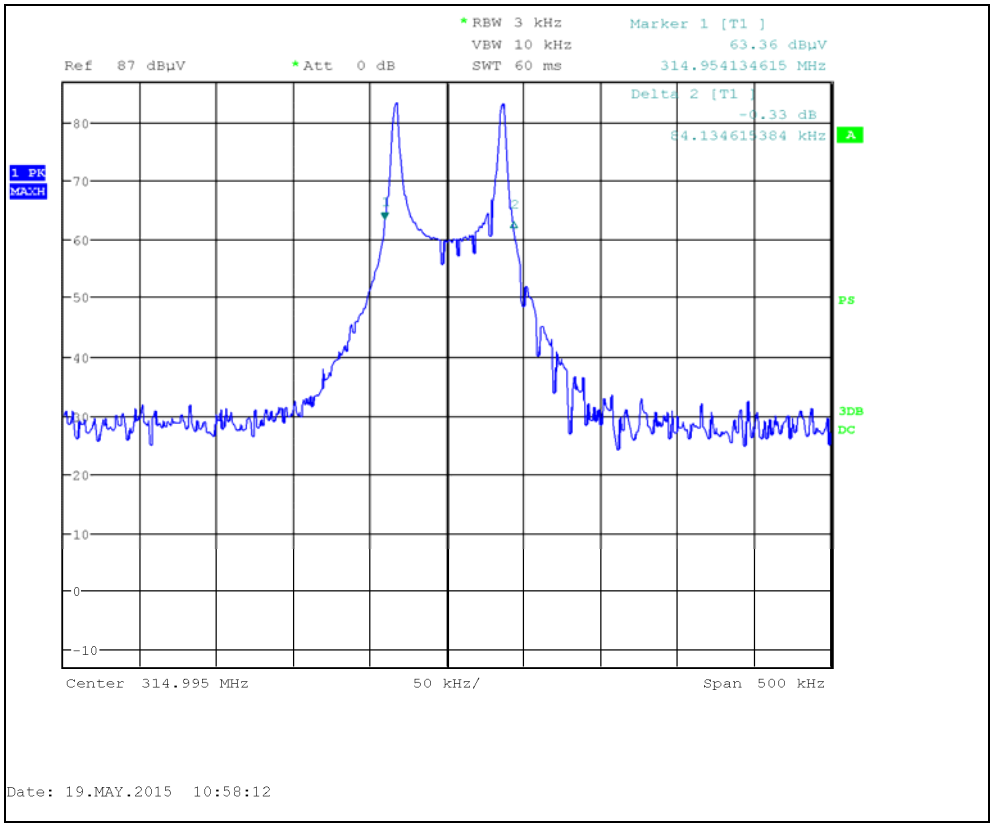

Figure 7.4.2-1: 20 dB Bandwidth (FSK 34 kHz Deviation)

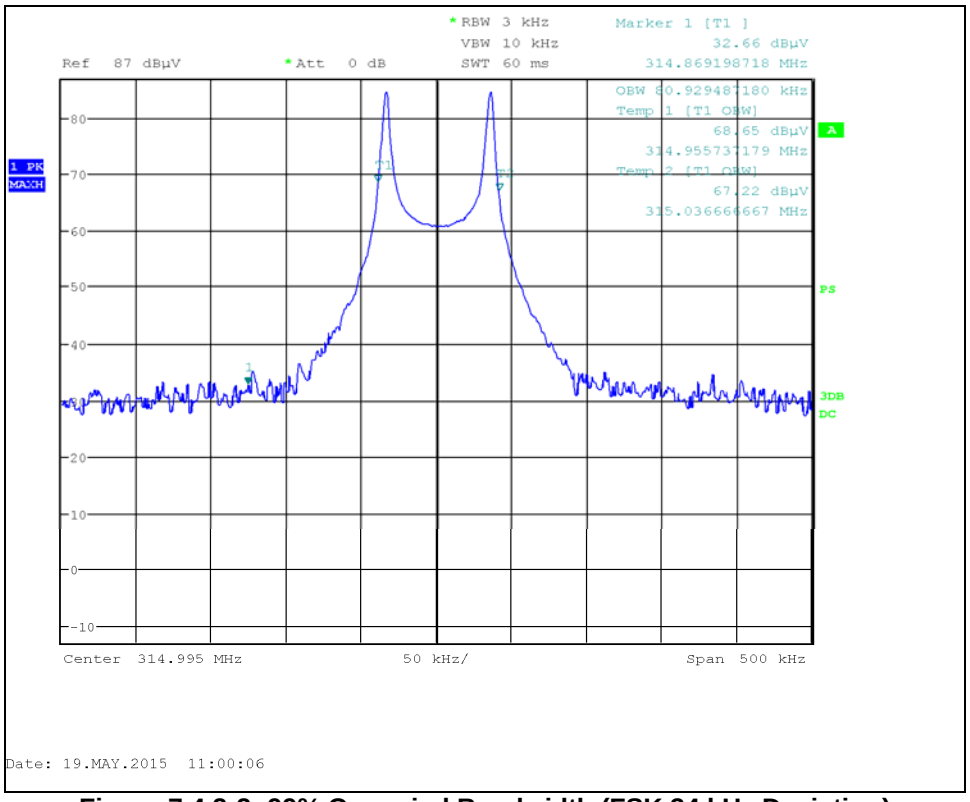

Figure 7.4.2-2: 99% Occupied Bandwidth (FSK 34 kHz Deviation)

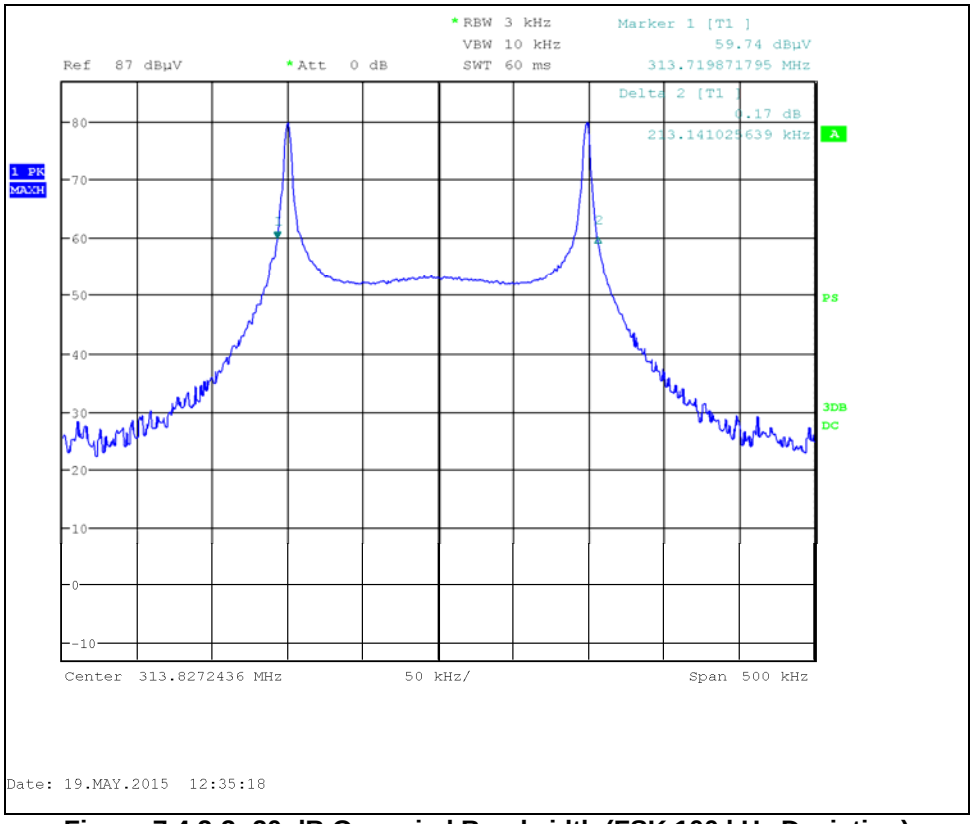

Figure 7.4.2-3: 20 dB Occupied Bandwidth (FSK 100 kHz Deviation)

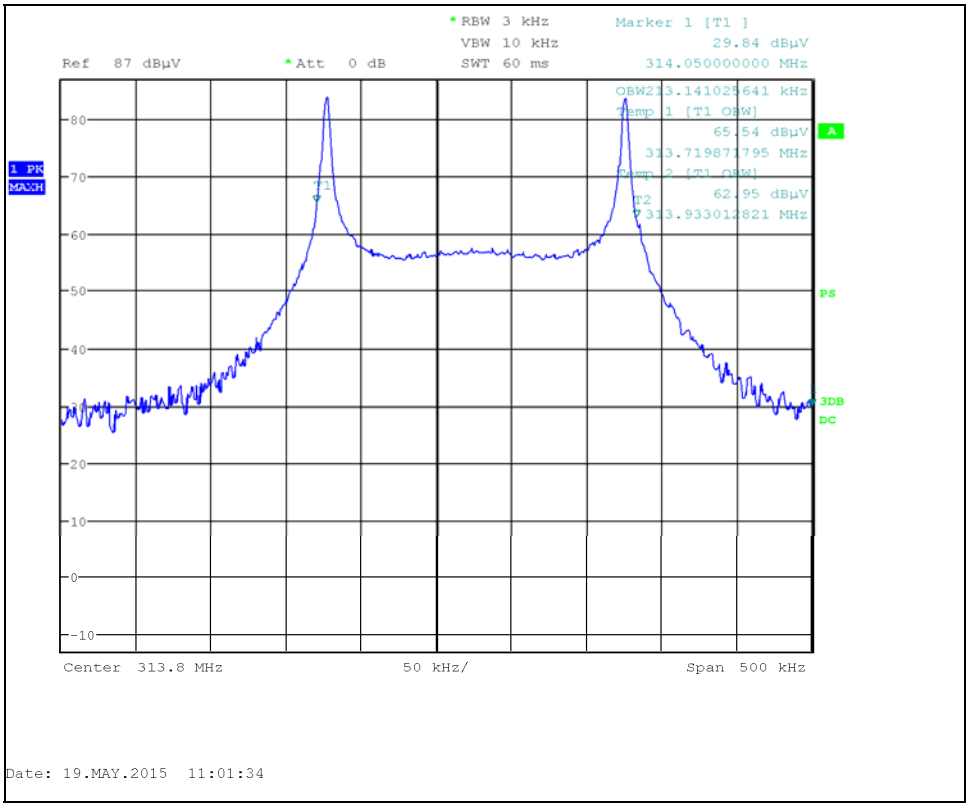

Figure 7.4.2-4: 99% Occupied Bandwidth (FSK 100 kHz Deviation)

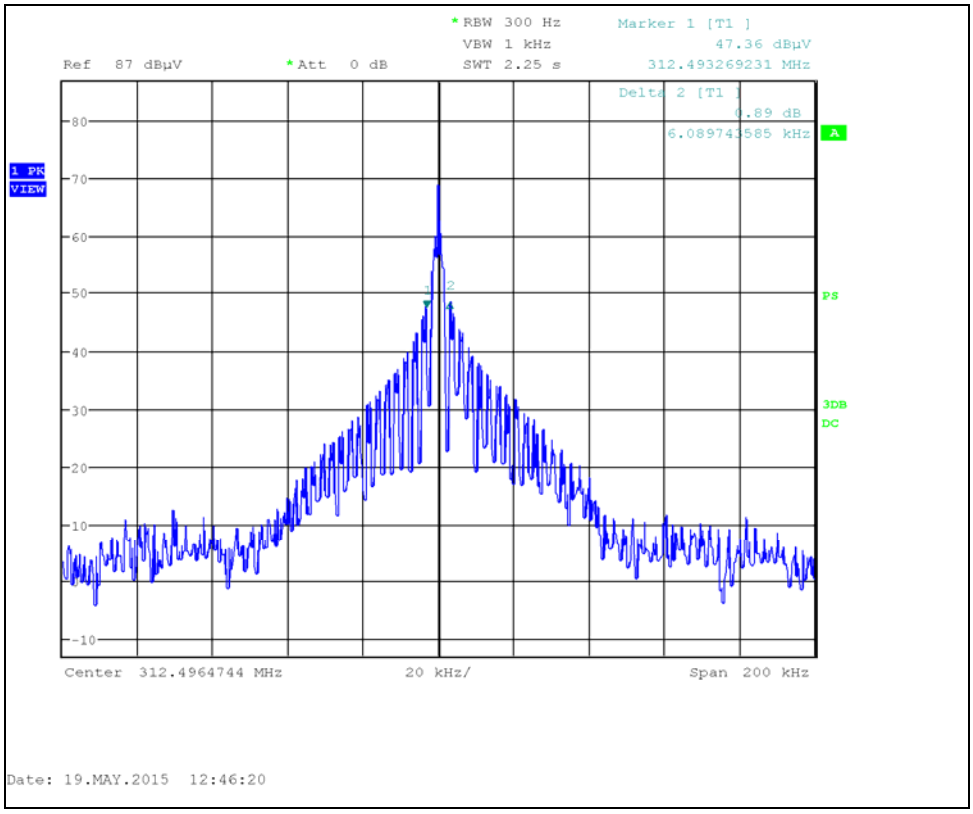

Figure 7.4.2-5: 20 dB Occupied Bandwidth (ASK)

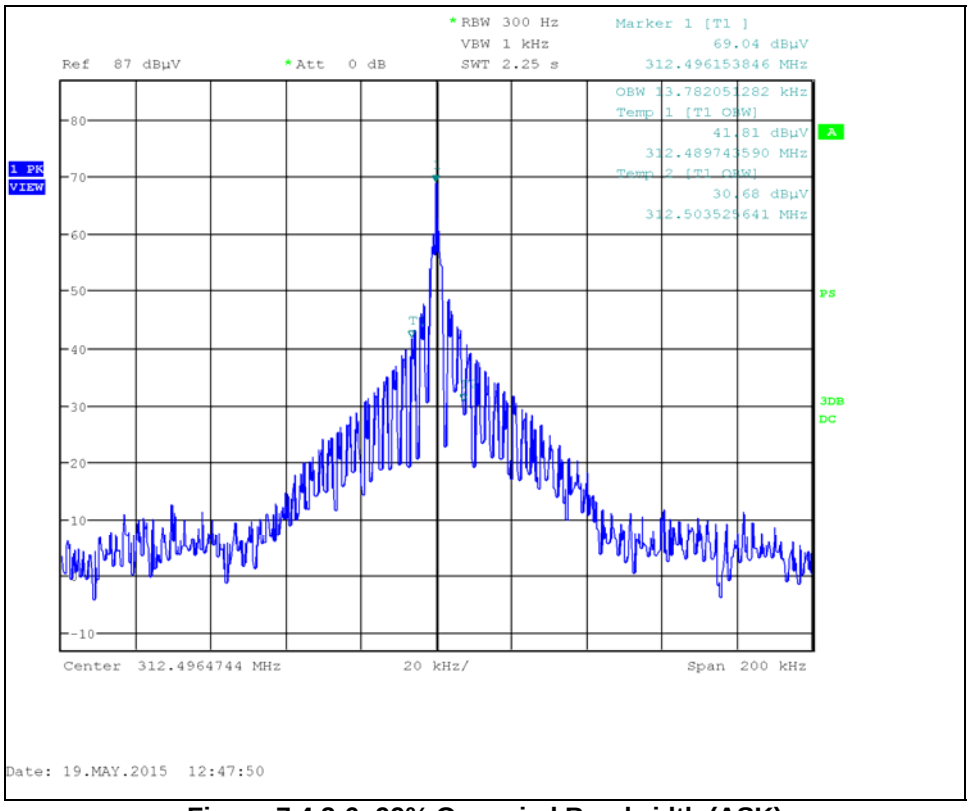

Figure 7.4.2-6: 99% Occupied Bandwidth (ASK)

7.5 Radiated Emissions – FCC: CFR 47 15.231(b) / IC: RSS-210 A1.1.2

7.5.1 Test Methodology

Radiated emissions tests were made over the frequency range of 9 kHz or the lowest frequency generated to 3.1516GHz, 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, 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.

Further, compliance with the provisions of 15.205 was demonstrated using the measurement instrumentation specified in that section where applicable.

For ASK modulation the EUT utilized pulsed modulation therefore peak measurements where corrected by the duty cycle for comparison to the average limits.

7.5.2 Duty Cycle Correction

For average radiated measurements, the measured level was reduced by a factor 4.07 dB to account for the duty cycle of the EUT with ASK modulation. There is no duty cycle correction for FSK modulation.

The manufacturer declares the worst case duty cycle for ASK modulation was determined to be 62.58%. The duty cycle correction factor is determined using the formula: 20log (0.626/100) = 4.07 dB.

Each ASK data payload consists of 16 PWM timing bits followed by 133 PWM data bits. Each PWM encoded ‘1’ is 420µs in duration. Therefore, we calculate our worst case ASK duty cycle in a 100ms window to be:
(16 + 133) * (420µs) / 100ms = 0.6258
Worst case ASK duty cycle = 62.58%

The test lab determination of the duty cycle correction factor is included in the plots and justification below.

ASK Duty Cycle Determination:

Period (T) = 102
Number Pulses (N1) = 6+5=11
Pulse Width (T1) = .37ms
Number Pulse (N2) = 1
Pulse Width (T2) = 4ms
Number Pulse (N3) = 60+2=62
Pulse Width (T3) = .69ms
(N1*T1 + N2*T2 + N3*T3)/T = ((11*.37) + (1*4) + (62*.69))/100 = 51
20*Log(0.51) = 5.85 dB Average Correction Factor (from plots below)

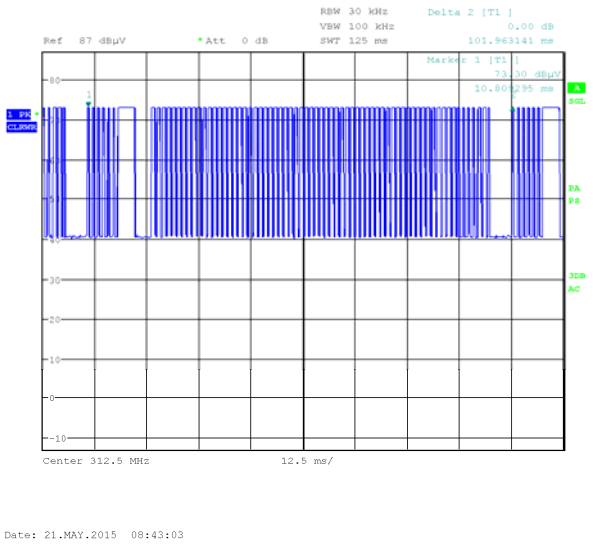

Figure 7.5.2-1: Duty Cycle

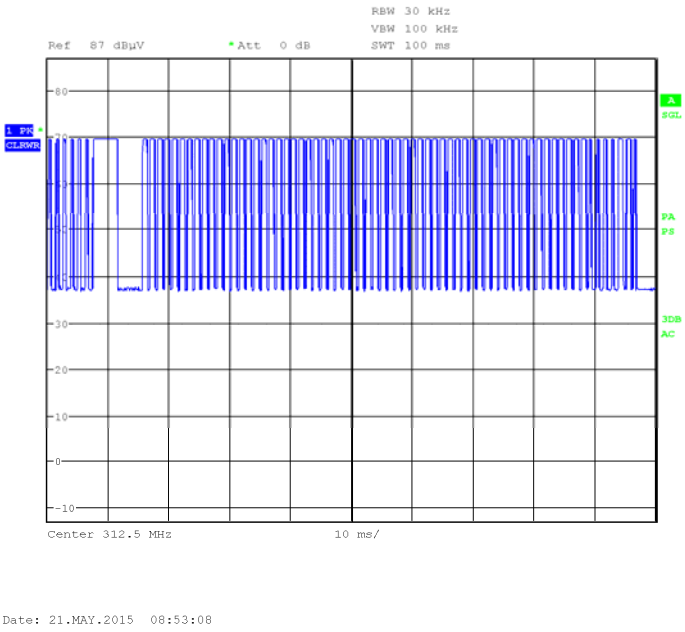

Figure 7.5.2-2: Duty Cycle

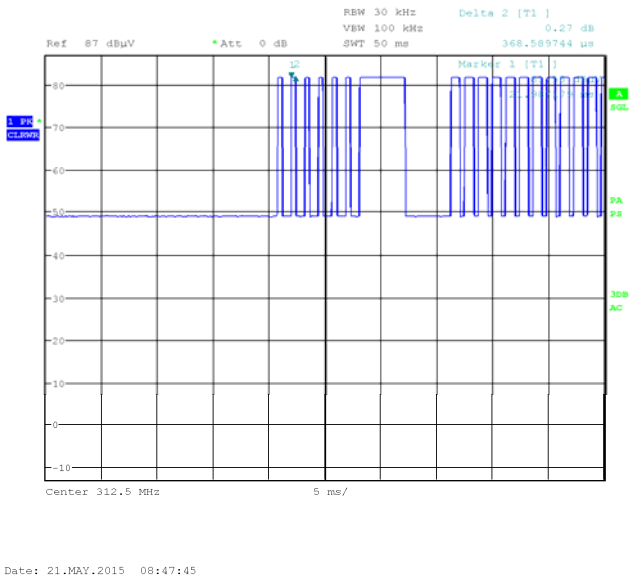

Figure 7.5.2-3: Duty Cycle –Pulse Width (T1)

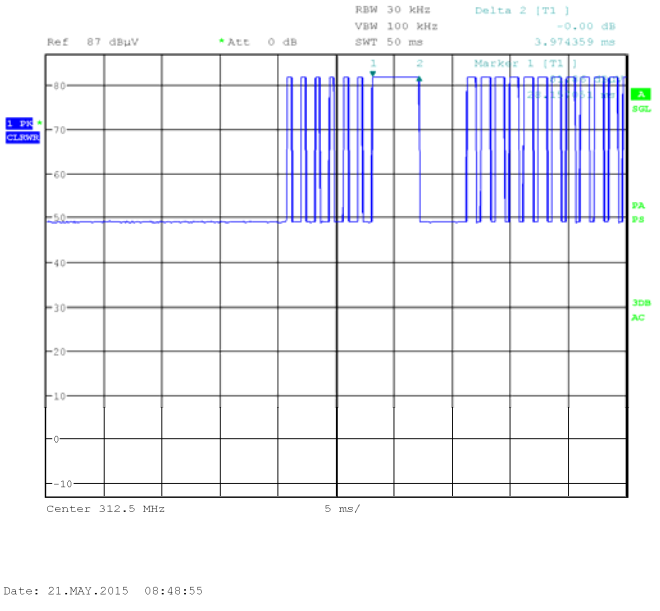

Figure 7.5.2-4: Duty Cycle – Pulse Width (T2)

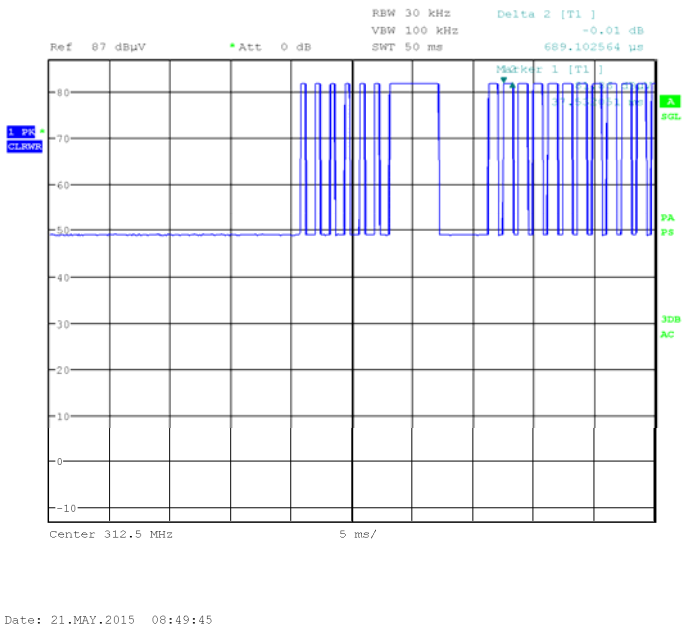

Figure 7.5.2-5: Duty Cycle – Pulse Width (T3)

7.5.3 Test Results

X, Y and Z positions were pre-scanned and X position was determined to be the worst case and are reported in Tables 7.5.3-1 to 7.5.3-4.

Table 7.5.3-1: Radiated Emissions – X Position (ASK – 312.5 MHz)

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										
312.5	58.00	58.00	H	16.22	74.22	70.15	95.5	75.5	21.3	5.3
Spurious Emissions										
625	30.00	30.00	H	20.94	50.94	46.87	75.5	55.5	24.6	8.6
937.5	18.20	18.20	H	24.01	42.21	38.14	75.5	55.5	33.3	17.3
1250	39.90	39.90	H	-5.31	34.59	30.52	75.5	55.5	40.9	25.0
1562.5	41.50	41.50	H	-4.66	36.84	32.77	74.0	54.0	37.2	21.2
1875	47.50	47.50	H	-3.73	43.78	39.71	75.5	55.5	31.7	15.8
2187.5	50.80	50.80	H	-2.80	48.00	43.93	75.5	55.5	27.5	11.5
2500	48.80	48.80	H	-1.89	46.91	42.84	74.0	54.0	27.1	11.2
2812.5	43.10	43.10	H	-0.73	42.37	38.30	74.0	54.0	31.6	15.7
3125	51.50	51.50	H	0.46	51.96	47.89	75.5	55.5	23.5	7.6

Table 7.5.3-2: Radiated Emissions – X Position (ASK – 315.16 MHz)

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										
315.2	58.00	58.00	H	15.98	73.98	69.91	95.6	75.6	21.6	5.7
Spurious Emissions										
630.4	29.30	29.30	H	20.97	50.27	46.20	75.6	55.6	25.3	9.4
945.6	17.40	17.40	H	24.13	41.53	37.46	75.6	55.6	34.1	18.2
1260.8	39.20	39.20	H	-5.29	33.91	29.84	75.6	55.6	41.7	25.8
1576	40.00	40.00	H	-4.62	35.38	31.31	74.0	54.0	38.6	22.7
1891.2	51.80	51.80	H	-3.68	48.12	44.06	75.6	55.6	27.5	11.6
2206.4	52.70	52.70	H	-2.75	49.95	45.88	74.0	54.0	24.0	8.1
2521.6	48.30	48.30	H	-1.81	46.49	42.42	75.6	55.6	29.1	13.2
2836.8	50.30	50.30	H	-0.64	49.66	45.59	74.0	54.0	24.3	8.4
3152	52.90	52.90	H	0.57	53.47	49.40	75.6	55.6	22.1	6.2

Table 7.5.3-3: Radiated Emissions – X Position (FSK - 313.83 MHz 100 kHz deviation)

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										
313.8	59.00	53.70	H	16.10	75.10	69.80	95.6	75.6	20.5	5.7
Spurious Emissions										
627.6	28.30	17.20	H	20.94	49.24	38.14	75.6	55.6	26.4	17.4
941.4	15.00	2.00	H	23.91	38.91	25.91	75.6	55.6	36.7	29.6
1255.2	39.80	26.00	H	-5.30	34.50	20.70	75.6	55.6	41.1	34.9
1569	41.00	28.00	H	-4.64	36.36	23.36	74.0	54.0	37.6	30.6
1882.8	44.60	28.80	H	-3.70	40.90	25.10	75.6	55.6	34.7	30.5
2196.6	49.00	34.70	H	-2.78	46.22	31.92	75.6	55.6	29.4	23.6
2510.4	47.00	31.90	H	-1.85	45.15	30.05	75.6	55.6	30.5	25.5
2824.2	44.20	30.90	H	-0.68	43.52	30.22	74.0	54.0	30.5	23.8
3138	50.80	39.10	H	0.51	51.31	39.61	75.6	55.6	24.3	15.9

Table 7.5.3-4: Radiated Emissions – X Position (FSK - 315 MHz 34 kHz deviation)

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	60.00	59.40	H	16.00	76.00	75.40	95.6	75.6	19.6	0.2
Spurious Emissions										
630	27.70	25.20	H	20.94	48.64	46.14	75.6	55.6	27.0	9.5
945	15.80	9.20	H	24.10	39.90	33.30	75.6	55.6	35.7	22.3
1260	39.80	26.30	H	-5.29	34.51	21.01	75.6	55.6	41.1	34.6
1575	41.00	31.40	H	-4.63	36.38	26.78	74.0	54.0	37.6	27.2
1890	45.20	34.00	H	-3.68	41.52	30.32	75.6	55.6	34.1	25.3
2205	47.90	38.90	H	-2.75	45.15	36.15	74.0	54.0	28.9	17.9
2520	47.00	37.10	H	-1.82	45.18	35.28	75.6	55.6	30.4	20.3
2835	44.40	37.70	H	-0.64	43.76	37.06	74.0	54.0	30.2	16.9
3150	51.00	42.40	H	0.56	51.56	42.96	75.6	55.6	24.0	12.7

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: Fundamental Frequency (X Orientation)

PEAK:
Corrected Level: 58 + 15.98 = 73.98dBuV
Margin: 95.6dBuV – 73.98dBuV = 21.6dB

AVERAGE:
Corrected Level: 58 + 15.98 - 4.07 = 69.91dBuV
Margin: 75.6dBuV – 69.91dBuV = 5.7dB

8 CONCLUSION

In the opinion of ACS, Inc. the 300-0403 manufactured by iKeyless, LLC meets the requirements of FCC Part 15 subpart C and Industry Canada's Radio Standards Specification RSS-210.

END REPORT