H.B. Compliance Solutions

Intentional Radiator Test Report

For the

Microchip, Inc.

Wireless Remote Control Development Kit Key Fob

Tested under

The FCC Rules contained in Title 47 of the CFR, Part 15.231 for

Periodic Operation

Prepared for:

Microchip, Inc.

2355 West Chandler Blvd.

Chandler, AZ 85224

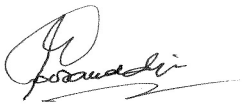
Prepared By:

H.B. Compliance Solutions

5005 S. Ash Avenue, Suite # A-10

Tempe, Arizona 85282

Reviewed By:



Hoosamuddin Bandukwala

Cert # ATL-0062-E

Engineering Statement: The measurements shown in this report were made in accordance with the procedure indicated, and the emissions from this equipment were found to be within the limits applicable. I assume full responsibility for the accuracy and completeness of these measurements, and for the qualifications of all persons taking them. It is further stated that upon the basis of the measurement made, the equipment tested is capable of operation in accordance with the requirements of Part 15 of the FCC Rules under normal use and maintenance.

Report Status Sheet

Revision #	Report Date	Reason for Revision
Ø	November 01, 2012	Initial Issue

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EXECUTIVE SUMMARY

1. Testing Summary

These tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with Part 15.231. All tests were conducted using measurement procedure from ANSI C63.4-2003, American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the range of 9kHz to 40GHz as appropriate.

Test Name	Test Method/Standard	Result	Comments
Unintentional Radiated Emissions	15.109	Pass	
A/C Power Line Conducted Emissions	15.207(a)	N/A	Battery Powered Device. Uses 1 Lithium Ion Battery
Occupied Bandwidth	15.231(c)	Pass	
Deactivation Time	15.231(a)(1)	Pass	
Duty Cycle	15.231	Pass	
Radiated & Spurious Emissions	15.231(b), 15.209(a), 15.205, 15.35(C)	Pass	

EQUIPMENT CONFIGURATION

1. Overview

H.B Compliance Solutions was contracted by Microchip, Inc. to perform testing on the Wireless Remote Control Development Kit Key Fob under the purchase order number 208611.

This document describes the test setups, test methods, required test equipment, and the test limit criteria used to perform compliance testing of the Microchip, Inc., Wireless Remote Control Development Kit Key Fob.

The tests were based on FCC Part 15 Rules. The tests described in this document were formal tests as described with the objective of the testing was to evaluate compliance of the Equipment Under Test (EUT) to the requirements of the aforementioned specifications. Microchip, Inc. should retain a copy of this document and it should be kept on file for at least five years after the manufacturing of the EUT has been permanently discontinued. The results obtained relate only to the item(s) tested.

Product Name:	Wireless Remote Control Development Kit Key Fob
Model(s) Tested:	N/A
FCC ID:	OA3RKE4331
Supply Voltage Input:	Primary Power : 3 Vdc
Frequency Range:	433.9 MHz
No. of Channels:	1
Type(s) of Modulation:	OOK
Range of Operation Power:	0.0008mW (Radiated)
Emission Designator:	N/A
Channel Spacing(s)	None
Test Item:	Pre-Production
Type of Equipment :	Portable
Antenna Requirement (§15.203) :	Type of Antenna: PCB Gain of Antenna: -10dBi
Environmental Test Conditions:	Temperature: 15-35°C Humidity: 30-60% Barometric Pressure: 860-1060 mbar
Modification to the EUT:	None
Evaluated By:	Staff at Emerson Network & H.B Compliance Solutions
Test Date(s):	05/11/12 till 11/01/12

2. Test Facility

All testing was performed at Emerson Network Power. This facility is located at 2900 S. Diablo Way, Suite 190, Tempe, AZ 85282. All equipment used in making physical determination is accurate and bears recent traceability to the National Institute of Standards and Technology.

Test facility at Emerson Network power is an A2LA accredited test site. The A2LA certificate number is 2716.01. The scope of accreditation covers the FCC Method - 47 CFR Part 15, ICES-003, CISPR 22, AS/NZS 3548 and VCCI

Radiated Emissions measurements were performed in a semi-anechoic chamber (equivalent to an Open Area Test Site). In accordance with §2.948(a)(3), a complete site description is contained at Emerson Network Power.

3. Description of Test Sample

The Microchip, Inc., Wireless Remote Control Development Kit Key Fob is a development kit intended for remote keyless entry systems. The device operates at 433.9 MHz (Nominal). The operating voltage is 3VDC typical.

4. Equipment Configuration

Ref. ID	Name / Description	Model Number	Serial Number
# 1	Wireless Remote Control Development Kit Key Fob	None	None

Table 1. Equipment Configuration

5. Support Equipment

All support equipment supplied is listed in the following Support Equipment List.

Ref ID	Name / Description	Manufacturer	Model #	Serial #
	None			

Table 2. Support Equipment

6. Ports and Cabling Information

Ref ID	Port name on the EUT	Cable Description	Qty.	Length (m)	Shielded? (Y/N)	Termination Box ID & Port ID
	None					

Table 3. Ports and Cabling Information

7. Method of Monitoring EUT Operation

A test receiver will be used to monitor the data transmission from the EUT.

8. Mode of Operation

The EUT will be configured to transmit at maximum power level. Test mode was provided to select between CW to modulated mode by a cloner programmer unit. These settings were created for testing purpose only.

9. Modifications

9.1 Modifications to EUT

No modifications were made to the EUT

9.2 Modifications to Test Standard

No Modifications were made to the test standard.

10. Disposition of EUT

The test sample including all support equipment submitted to H.B Compliance Solutions for testing will be returned to Microchip Inc. upon completion of testing & certification

Criteria for Un-Intentional Radiators

1. Radiated Emissions

Test Requirement(s):	§15.109	**Test Engineer(s):**	Frank Farrone
Test Results:	Pass	**Test Date(s):**	06/13/2012

Test Procedures:

The final radiated emissions test was performed using the parameters described above as worst case. That final test was conducted at a facility that meets the ANSI C63.4 NSA requirements. The frequency range noted in the data sheets was scanned/tested at that facility. Emissions were maximized as specified, by varying table azimuth, antenna height, and manipulating cables.

Using the mode of operation and configuration noted within this report, a final radiated emissions test was performed. The frequency range investigated (scanned), is also noted in this report. Radiated emissions measurements were made at the EUT azimuth and antenna height such that the maximum radiated emissions level will be detected. This requires the use of a turntable and an antenna positioner. The preferred method of a continuous azimuth search is utilized for frequency scans of the EUT field strength with both polarities of the measuring antenna. A calibrated, linearly polarized antenna was positioned at the specified distance from the periphery of the EUT.

> *Note: The specified distance is the horizontal separation between the closest periphery of the EUT and the center of the axis of the elements of the receiving antenna. However, if the receiving antenna is a log-periodic array, the specified distance shall be the distance between the closest periphery of the EUT and the front-to-back center of the array of elements.*

Tests were made with the antenna positioned in both the horizontal and vertical polarization planes. The measurement was varied in height above the conducting ground plane to obtain the maximum signal strength. Though specified in the report, the measurement distance shall be 3 meters. At any measurement distance, the antenna height was varied from 1 meter to 4 meters. These height scans apply for both horizontal and vertical polarization, except that for vertical polarization the minimum height of the center of the antenna shall be increased so that the lowest point of the bottom of the antenna clears the ground surface by at least 25 cm.

Frequency Range (MHz)	Peak Data (kHz)	Quasi-Peak Data (kHz)	Average Data (kHz)
30 MHz to 1 GHz	120 kHz	120 kHz	N/A
1 GHz to 11 GHz	1MHz	N/A	1MHz
Measurements were made using the bandwidths and detectors specified. The video filter was at least as wide as the IF bandwidth of the measuring receiver.			

Table 4. Radiated Emissions – Measurement Bandwidth

Emissions Tests Calculations

In the case of indoor measurements, radiated emissions measurements are made by the manipulation of correction factors using Rohde and Schwarz ES-K1 software. This is done automatically by the software during the final measurement process.

In both cases, the level of the Field Strength of the interfering signal is calculated by adding the Antenna Factor, Cable Factor and by subtracting the Amplifier Gain from the measured reading. The basic equation is as follows:

FS = RA + AF + (CF –AG)

Where: FS = Field Strength

RA = Receiver (indicated) Amplitude

AF = Antenna Factor

CF = Cable Attenuation Factor

AG = Amplifier Gain

This laboratory uses an approach of combining the CF and AG using an end-to-end measurement of the entire cabling system, including the test cable, any in-line amplifiers, attenuators, or transient protection networks, all measured in-situ.

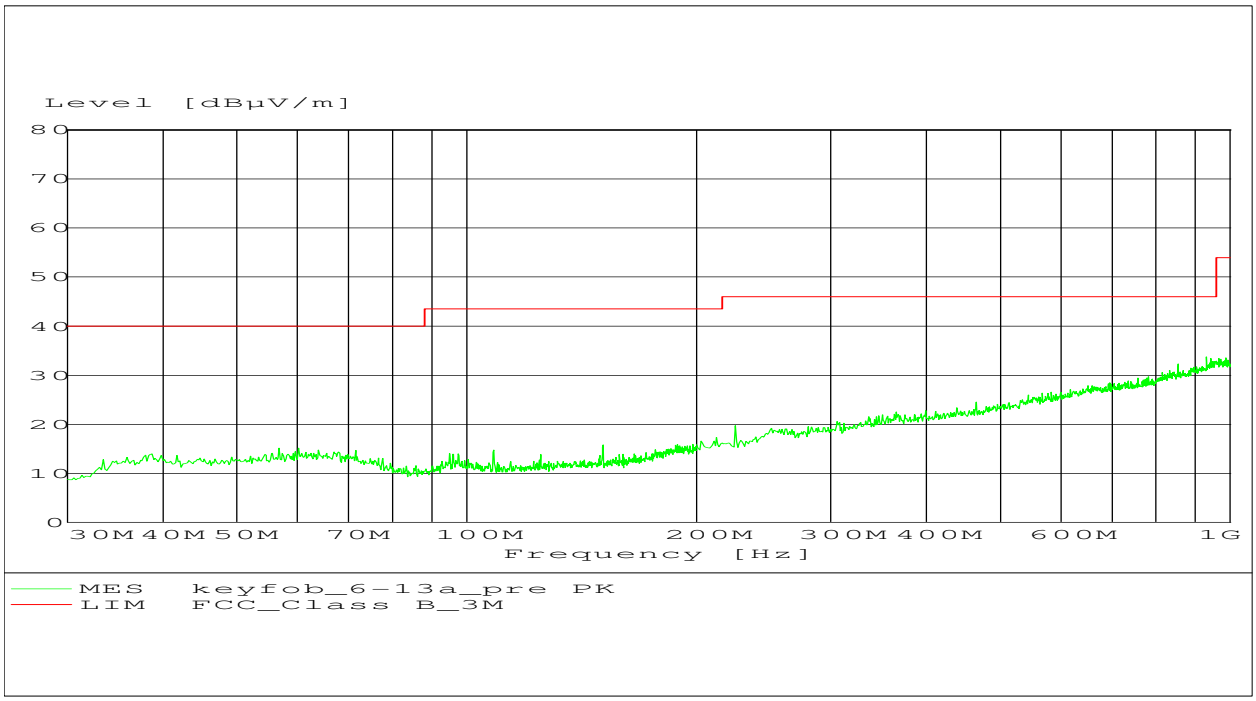
For a sample calculation, assume a receiver reading of 52.5 dBuV is obtained. With an antenna factor of 7.4 and a combined cable factor (CF + AG) of -27.9:

FS = 52.5 + 7.4 + (-27.9) = 32 dBuV/m

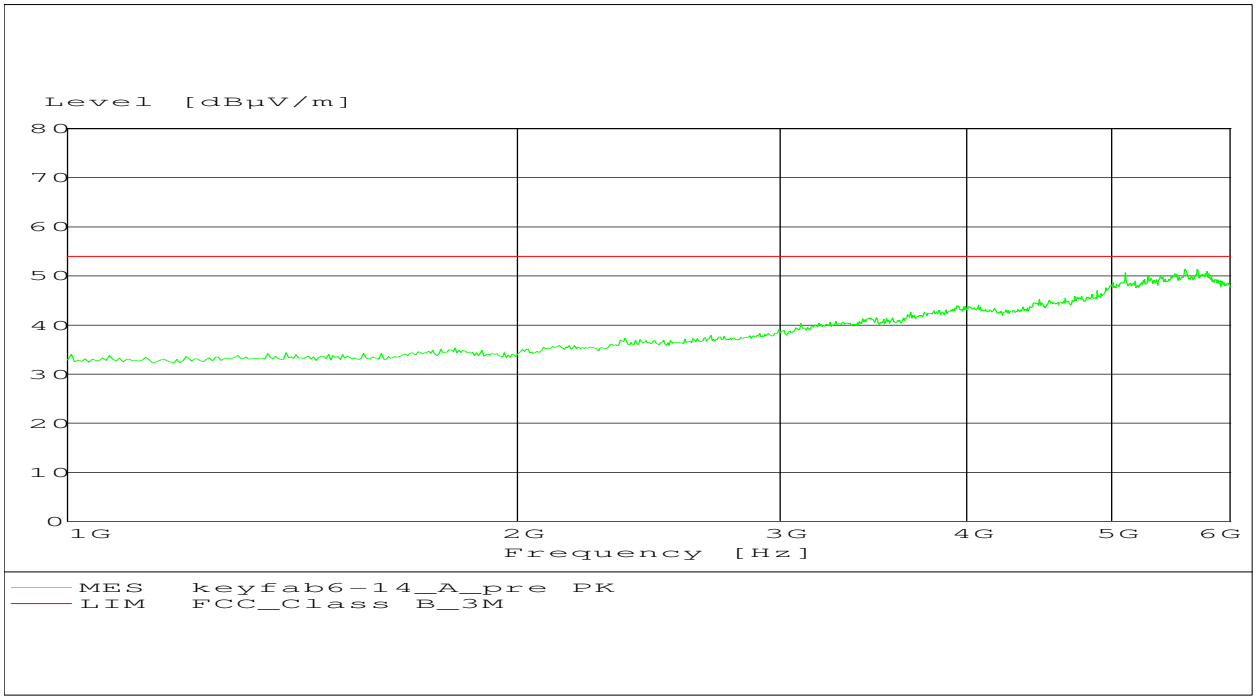
FS = 32 dBuV/m

If desired, this can be converted into its corresponding level in uV/m:

FS = 10^((32 dBuV/m)/20) = 39.8 uV/m



Plot 1 – Radiated Emissions – 30MHz to 1GHz



Plot 2 – Radiated Emissions – 1GHz to 6GHz

Frequency (MHz)	Measured Level	Height(cm)	Azimuth (deg)	Polarization
See Graph Above	None	None	None	None

Table 5. Final Measurement Results for Radiated Emissions

Note: All digital emissions were below the test limit.

2. Conducted Emissions

Test Requirement(s):	§15.207	**Test Engineer(s):**	N/A
Test Results:	Battery powered device	**Test Date(s):**	N/A

Test Procedures: The EUT was placed on a non-metallic table, 80cm above the ground plane inside a shielded enclosure. The EUT was powered through a 50Ω/50µH LISN. The conducted emissions tests were performed using the mode of operation and configuration noted within this report. The frequency range investigated (scanned), is also noted in this report. Conducted power line measurements are made, unless otherwise specified, over the frequency range from 150 kHz to 30 MHz to determine the line-to-ground radio-noise voltage that is conducted from the EUT power-input terminals that are directly (or indirectly via separate transformer or power supplies) connected to a public power network. Equipment is tested with power cords that are the same as those cords normally used or that have electrical or shielding characteristics that are the same as those cords normally used. Typically those measurements are made using a LISN (Line Impedance Stabilization Network). All 50 Ohm measuring ports of the LISN are terminated by 50 Ohms, either by the 50 Ohm EMI receiver or a 50 Ohm resistive load.

Refer to the Emissions Tests Calculations section in the Radiated Emissions section for sample calculations. For the purposes of the conducted emissions test, the Antenna Factor (AF) is replaced by the LISN correction factor.

Frequency Range (MHz)	Peak Data (kHz)	Quasi-Peak Data (kHz)	Average Data (kHz)
0.150 - 30	9.0	9.0	9.0
Measurements were made using the bandwidths and detectors specified. No video filter was used.			

Table 6.Conducted Emissions – Measurement Bandwidth

Frequency Range (MHz)	15.107(b), Class A Limits (dBuV)		15.107(a), Class B Limits (dBuV)	
	Quasi-Peak	Average	Quasi Peak	Average
0.15 – 0.5	79	66	66 - 56	56 - 46
0.5 – 5.0	73	60	56	46
5.0 – 30	73	60	60	50
Note 1 – The lower limit shall apply at the transition frequencies.				

Table 7. Conducted Emissions Limits – FCC Limits from Section 15.107(a)(b)

2. Occupied Bandwidth

Test Requirement(s):	15.231(c)	**Test Engineer(s):**	Hoosam B.
Test Results:	Pass	**Test Date(s):**	05/11/12

Test Procedure: As required by 47 CFR 15.231(c): The bandwidth of the emission shall be no wider than 0.25% of the center frequency for devices operating above 70 MHz and below 900 MHz. Bandwidth is determined at the points 20 dB down from the modulated carrier.

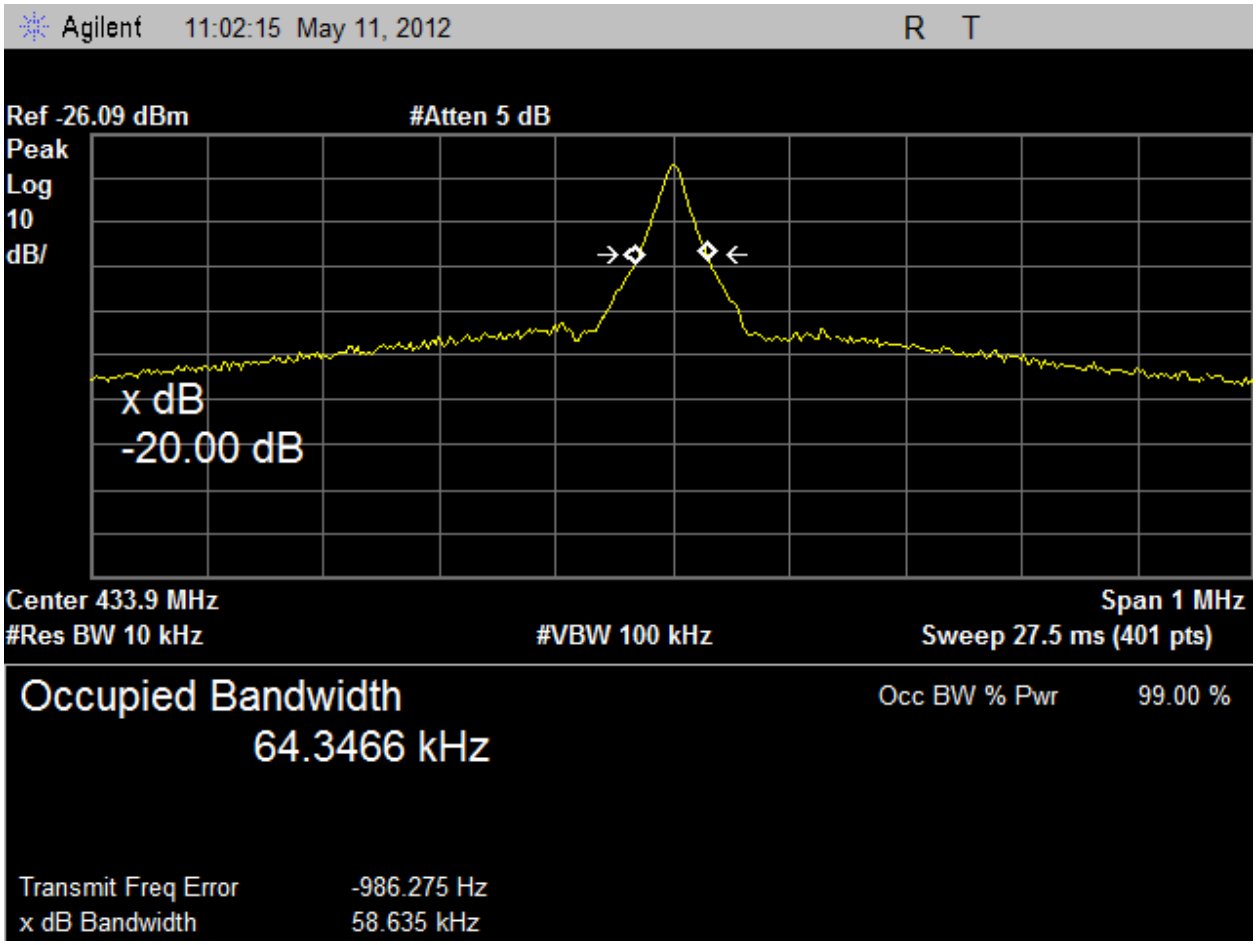
Customer provided a test mode internal to the EUT to control the RF modulation. The EUT antenna was attached and the waveform was received by the test antenna which was connected to the spectrum analyzer. The measured highest peak power was set relative to zero dB reference. The RBW of the Spectrum Analyzer was set to 10kHz and VBW>RBW.

Frequency (MHz)	Recorded Measurement	Specification Limit
433.9	58.635 kHz	1.0 MHz

Table 8. Occupied Bandwidth Summary, Test Results

Note: Limit = 0.25%*Center Frequency = 0.25% * 433.9 MHz = 1.08 MHz

The following pages show measurements of Occupied Bandwidth plot:



Plot 1 – 20dB BW OOK Modulation & 99% Occupied BW (For IC Only)

3. Deactivation Time

Test Requirement(s):	§15.231(a)(1)	Test Engineer(s):	Hoosam B.
Test Results:	Pass	Test Date(s):	11/01/2012

Test Procedures: As required by 47 CFR 15.231(a)(1), A manually operated transmitter shall employ a switch that will automatically deactivate the transmitter within not more than 5 seconds of being released.

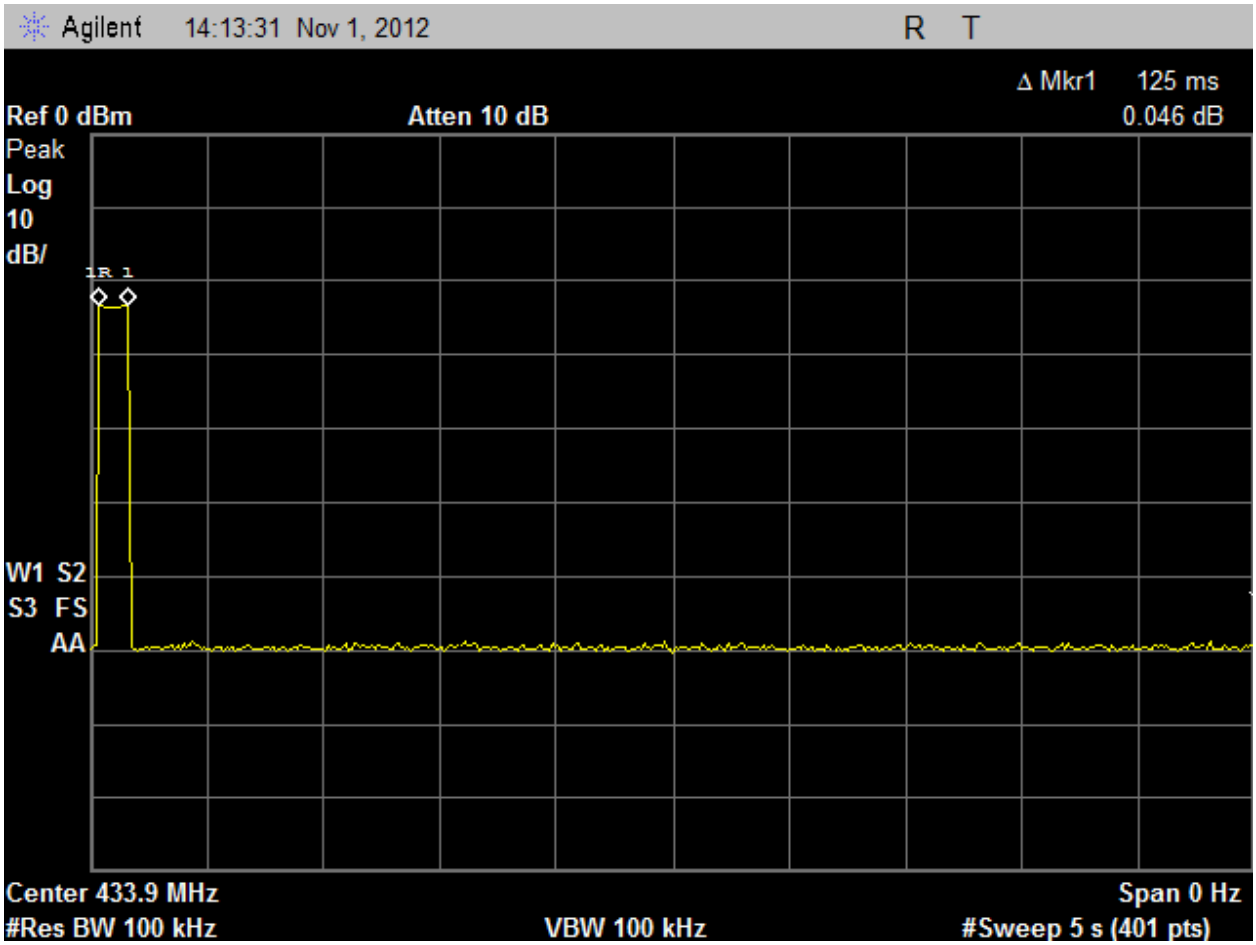
Customer provided a test mode internal to the EUT to control the RF modulation. The EUT antenna was attached and the waveform was received by the test antenna which was connected to the spectrum analyzer. The device was operated and the transmission time was measured with the spectrum analyzer set to zero span at the fundamental frequency

Detector Setting	Resolution Bandwidth	Video Bandwidth	Span
Peak	See Plot	See Plot	Zero

Table 9 – Analyzer settings

Frequency (MHz)	Transmission Time (Sec)	Specification Limit (Sec)
433.9	0.125	5 seconds or less

Table 10 - Deactivation Time Test Results



Plot 2 – Deactivation Time – Continuous Transmit Mode

5. Duty Cycle

Test Requirement(s):	§15.231	**Test Engineer(s):**	Hoosam B.
Test Results:	Pass	**Test Date(s):**	05/28/12

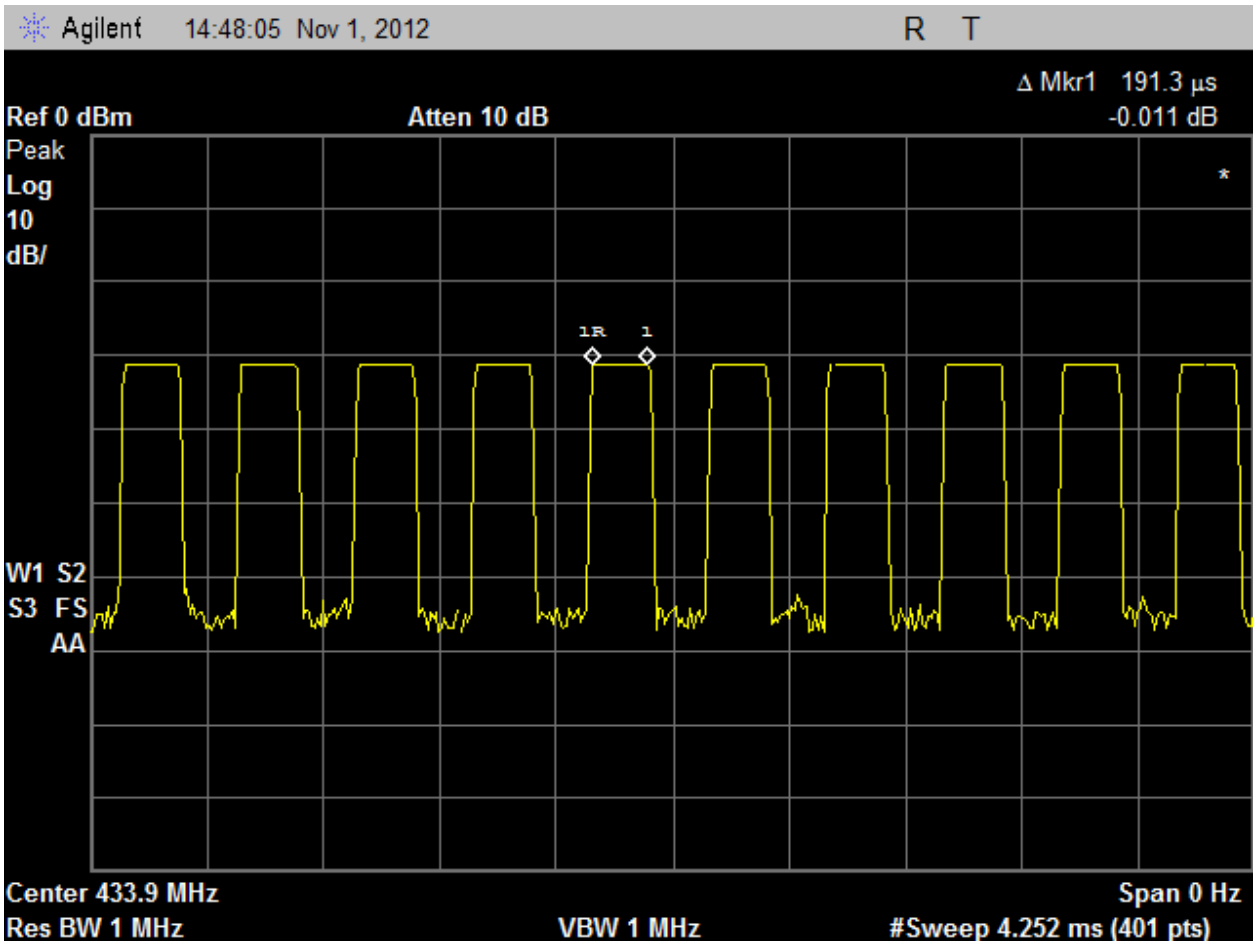
Test Procedures:

There are no limits for this test. This data is used to calculate the averaging correction factor that is applied to the measured peak radiated emissions results.

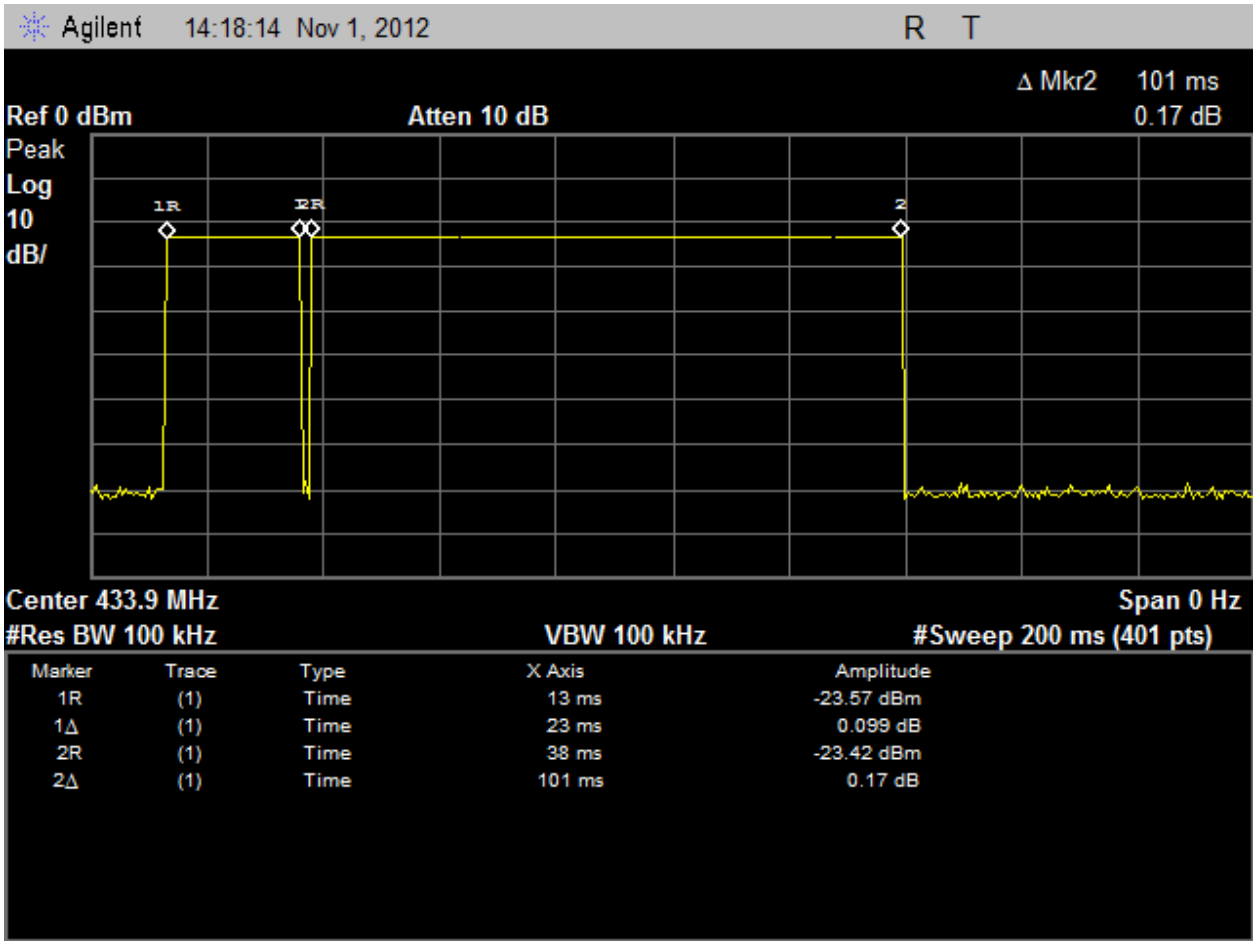
Customer provided a test mode internal to the EUT to control the RF modulation. The EUT antenna was attached and the waveform was received by the test antenna which was connected to the spectrum analyzer. The device was operated and the pulse train /duty cycle was measured with the spectrum analyzer set to zero span at the fundamental frequency.

Frequency (MHz)	Pulse Width (mS)	Period or 100ms whichever is lesser	Average Correction Factor (dB) 20log(PulseWidth/TotalTransmission Time)
433.9	66.8	100ms	-3.5

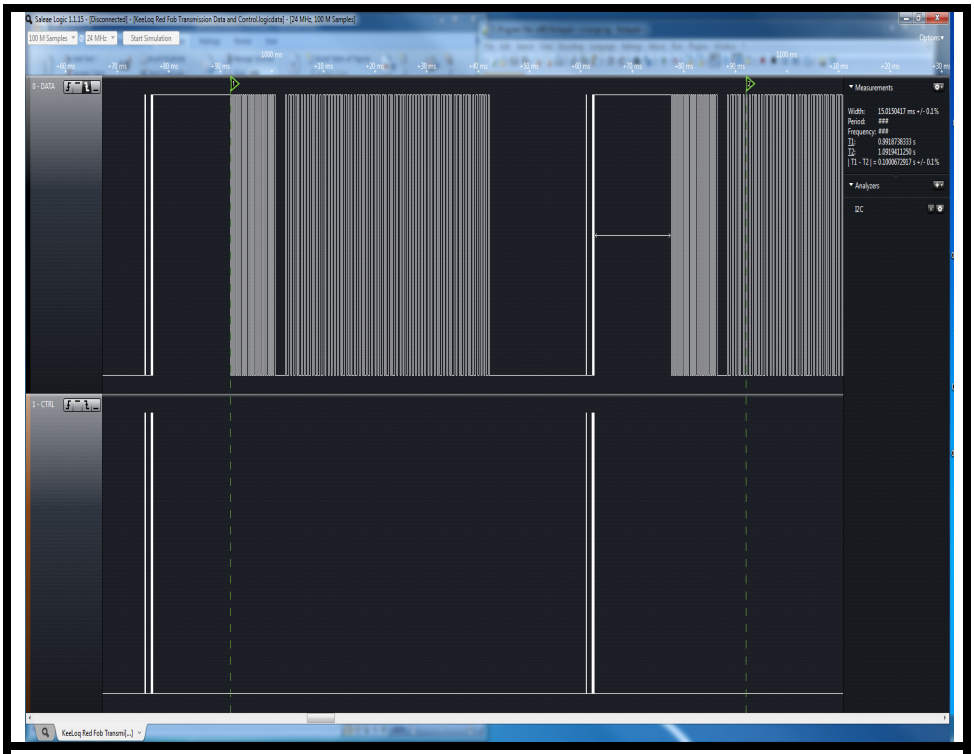
Table 11- Duty Cycle Calculation



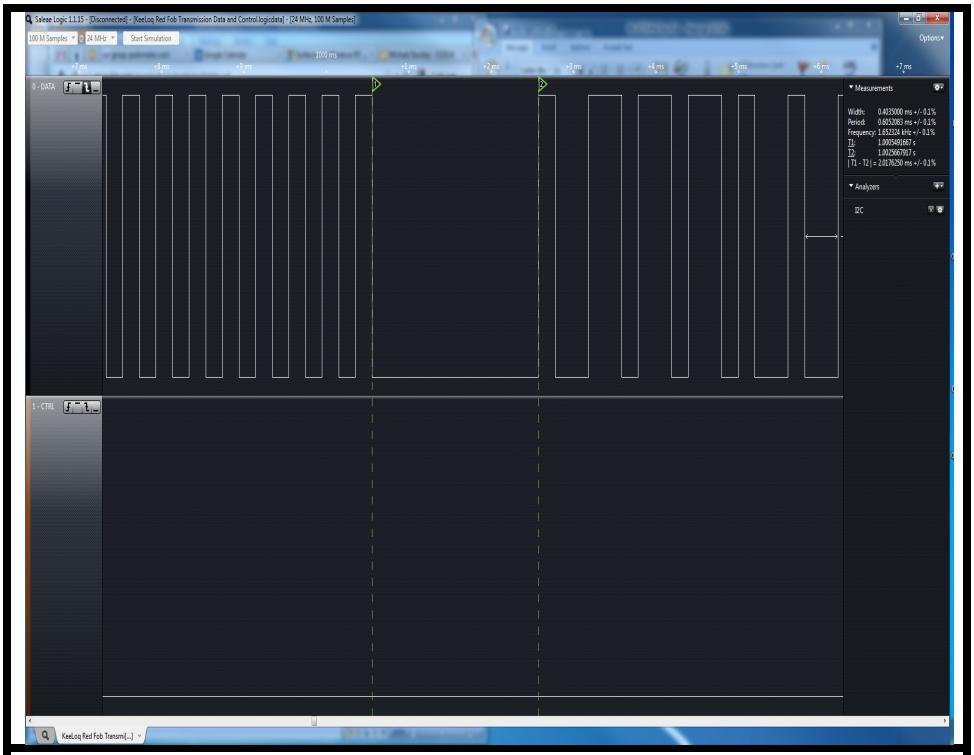
Plot 3 – Duty Cycle – Pulse Data Stream



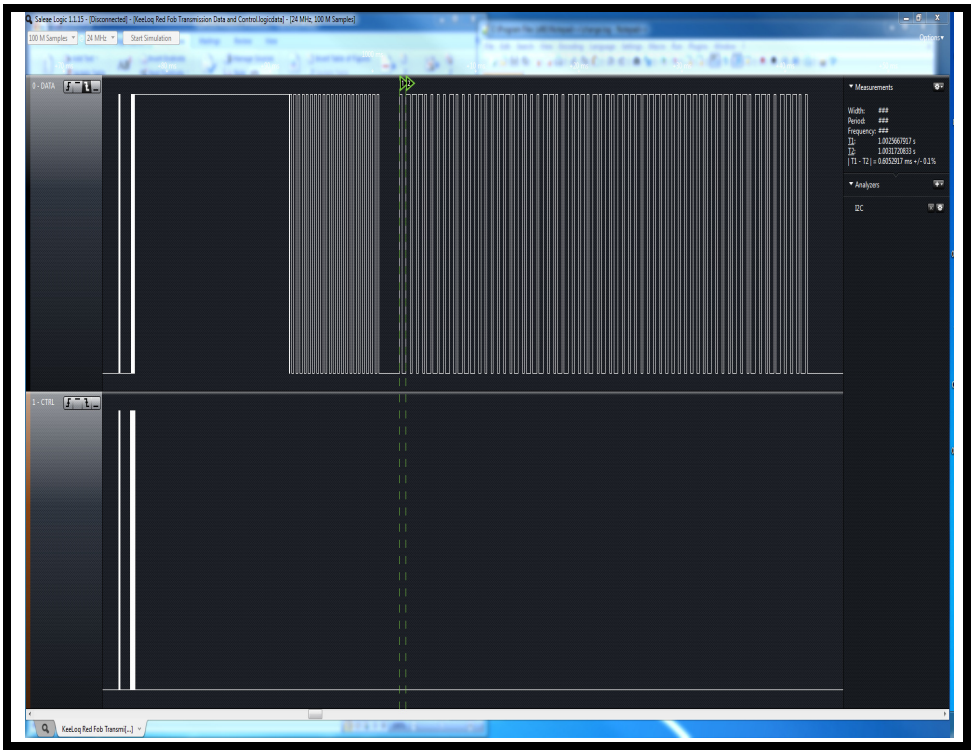
Plot 4 – Duty Cycle – Period



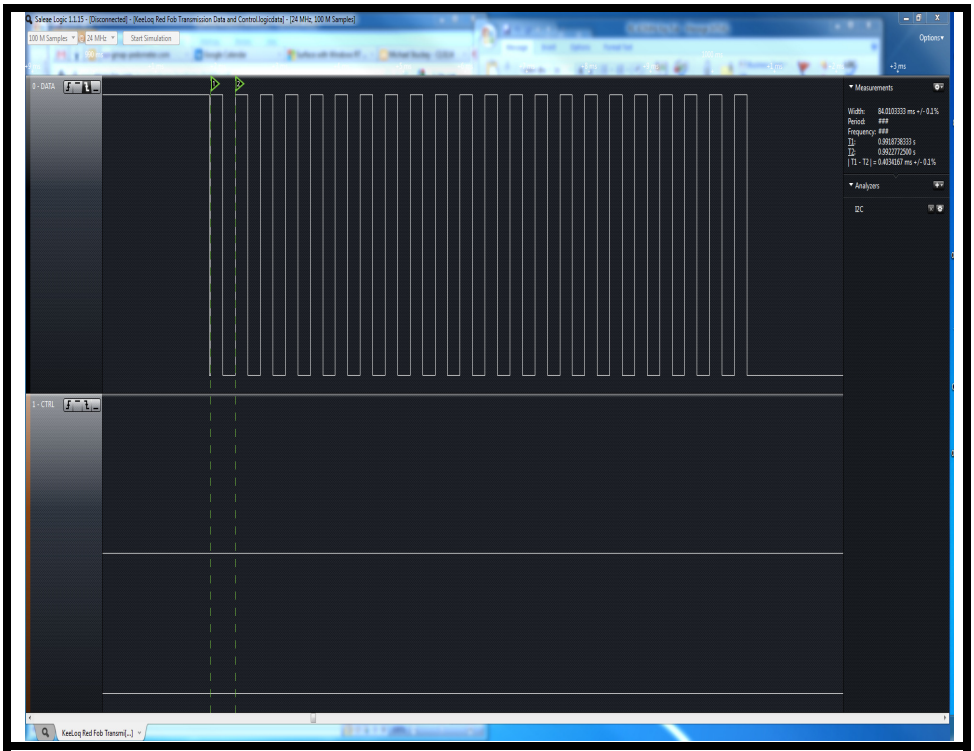
100ms Window



Header Detail



Packet Detail



Preamble Detail

Customer Provided Details.

Above are the screen captures of the transmission,

A packet is made up of four components the Preamble, Header, Data, and Guard. All times are derived from a “Basic time element” Te.

The Header is 22Te “on” and 21Te “off” at 50% duty cycle.

The Preamble is 10Te “off”. Essentially, it is a quiet period.

The Guard is 20Te “off.”

Data is a bit more complex. Each data bit is lasts 3Te. The first Te is always high, the third is always low, and the middle is the inverse of the data bit being transmitted. So, for data bit “1” the transmission is 1Te “off” and 2Te “on.” For data bit “0” the transmission is 2Te “on” and 1Te “off.”

Data is also the only variable portion, as it depends on the actual data being sent. The worst case is if the data is all 0s, as that will have the highest on ratio of 2Te / 3Te = 66%.

For this transmitter, the basic time element is Te = 200 us, and the data bit length is 168 bits. This means the data portion will be longer than 100 ms. And, since it has the highest “on” duty cycle, we can calculate the “worst case window” from the data portion alone.

Total time: 168*3*Te = 100.8 ms.

This is 800 us over the window limit, so subtract 1 1/3 of a bit from the end of the transmission. That makes 166 full bit times, plus 2/3 of a bit, which will be entirely high because we are removing from the end of the transmission.

1*3*Te + 1*1*Te = 0.8 ms

Total on time: 166*2*Te + 1*2*Te = 66.8 ms.

From a 100 ms window, the transmitter is “on” 66.8% of the time.

6. Radiated and Spurious Emissions

Test Requirement(s):	§15.231(b), 15.209(a), 15.205, 15.35	**Test Engineer(s):**	Frank Farrone
Test Results:	Pass	**Test Date(s):**	06/14/12

Test Procedures: As required by 47 CFR 15.231, Radiated emission measurements were made in accordance with the procedures of the ANSI C63.4 - 2003.

The EUT was placed on a wooden table inside a 3 meter semi-anechoic chamber. The EUT was set on continuous transmit.

The measurement antenna was placed at a distance of 3 meters from the EUT. During the tests, the antenna height and polarization as well as EUT azimuth were varied in order to identify the maximum level of emissions from the EUT. The frequency range up to the 10^{th} harmonic was investigated.

Frequency Range	Detector Setting	Resolution Bandwidth	Video Bandwidth	Span
30MHz – 1000 MHz	Quasi Peak	120kHz	As Specified in §15.35(c)	Zero
1000 MHz – 5GHz	Peak	1MHz	1MHz	As necessary
1000 MHz – 5GHz	Average	1MHz	As Specified in §15.35(c)	As necessary

Table 12 - Analyzer Settings

The following table shows the highest levels of radiated emissions on both polarizations of horizontal and vertical

Frequency (MHz)	Peak Measurement @ 3m (dBuV/m)	Antenna Polarity (H/V)	Duty Cycle Correction (dB)	Average Amplitude (dBuV/m)	FCC Average Limit (dBuV/m)	FCC Peak Limit (dBuV/m)	Average Margin (dB)	Peak Margin (dB)	Comment
433.91	75.2	V	3.5	71.7	80.8	100.8	-9.1	-25.6	Fundamental
867.83	60.1	V	3.5	56.6	60.6	80.6	-4.0	-20.5	Harmonic
1301.74	53	V	3.5	49.5	54.0	74.0	-4.5	-21	Harmonic
1735.66	44.1	V	3.5	40.6	60.6	80.6	-20	-36.5	Harmonic
2169.58	47.1	V	3.5	43.6	60.6	80.6	-17	-33.5	Harmonic

Table 13 - Radiated Emission Data – 30MHz – 3GHz

Note: Frequency marked with "*" falls under the restricted band for Industry Canada and or FCC.

Remark:

To get a maximum emission level from the EUT, the EUT was moved throughout the X-axis, Y-axis and Z-Axis. Worst case is X-axis.

Test Equipment

Equipment	Manufacturer	Model	Serial #	Last Cal Date	Cal Due Date
Power Supply	H.P	E3610A	KR83021468	NCR	None
Spectrum Analyzer	Agilent	E4402B	USA1192757	Nov/10/11	Nov/10/12
DMM	H.P	34401A	US36054008	Nov/11/11	Nov/11/12
Combiner/Splitter	Mini-Circuits	ZFSC-2-2	None	NCR	None
High Pass Filter	Mini-Circuits	VHF-3100+	15542	NCR	None
Temperature Meter	Fluke	52	6767008	10/30/11	10/30/12
Attenuator 30dB	Bird	10-A-MFN-30	0031039	11/03/11	11/03/12
Variable Attenuator	H.P.	None	None	NCR	None
EMI Receiver	R&S	ESCS-30	828985/007	Sep/03/11	Sep/03/12
Signal Generator	R&S	SMY02	1062.5502.12	NCR	None
Attenuator 20dB	Mini Circuits	CAT-20	10012	NCR	None
Horn Antenna	EMCO	3115	9505-4428	Nov/04/11	Nov/04/12
Bilog Antenna	Chase	CBL6140	1040	Nov/09/11	Nov/09/12

Table 14 – Test Equipment List

***Statement of Traceability:** Test equipment is maintained and calibrated on a regular basis. All calibrations have been performed by a 17025 accredited test facility, traceable to National Institute of Standards and Technology (NIST)

END OF TEST REPORT