Excellence in Compliance Testing

Certification Test Report

FCC ID: AMH101003
IC: 10124A-101003

FCC Rule Part: 15.247
IC Radio Standards Specification: RSS-210

ACS Report Number: 12-2034.W06.1A

Manufacturer: Locus Solutions LLC
Model: Smart Tag

Test Begin Date: **March 22, 2012**
Test End Date: **April 9, 2012**

Report Issue Date: September 12, 2012

ACCREDITED
TESTING

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 ACLASS, ANSI, or any agency of the Federal Government.

Project Manager:

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Advanced Compliance Solutions, Inc.

Reviewed by:

Kirby Munroe
Director, Wireless Certifications
Advanced Compliance Solutions, Inc.

This report contains 30 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 Locus Solutions, LLC. Smart Tag is a 2.4 GHz wireless transceiver. The Smart Tag is used to monitor shipment location, temperature and other conditions as well as shipment sensors. The Smart Tag communicates the information via an IEEE 802.15.4 local wireless network to a central portable or fixed unit.

Technical Information:

Band of Operation:	2405 MHz - 2480 MHz
Number of Channels:	16
Modulation Format:	OQPSK
Antenna Type/Gain:	Printed Inverted-F Antenna, 3 dBi
Operating Voltage:	4.2 VDC

Manufacturer Information:

Locus Solutions LLC
630 Maplewood Drive, Suite 200
Jupiter, FL 33418

Test Sample Serial Number(s): 007003082, 007003120

Test Sample Condition: The unit was in good operating condition with no physical damages.

1.3 Test Methodology and Considerations

The Locus Solutions, Inc. Smart Tag was programmed via serial port using the Hyperterminal. The power settings were set to level 3 across the range of operation for the evaluation.

The unit was evaluated for radiated and RF conducted measurements. For the radiated emissions evaluation, the unit was setup in three orthogonal orientations. The final measurements were performed using the orientation leading to the highest emissions.

The RF conducted measurements were performed with a temporary SMA connector at the RF port of the EUT.

The evaluation for the unintentional emissions is documented separately in a Verification Report.

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

FCC Test Firm Registration #: 587595
Industry Canada Lab Code: 4175C

2.2 Laboratory Accreditations/Recognitions/Certifications

ACS is accredited to ISO/IEC 17025 by ANSI-ASQ National Accreditation Board under their ACLASS 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.

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 floor.

The turntable is driven by pneumatic motor, which is capable of supporting a 2000 lb. load. The turntable is flushed with the chamber floor which it is connected to, around its circumference, with a continuous metallic loaded spring. An EMCO Model 1050 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:

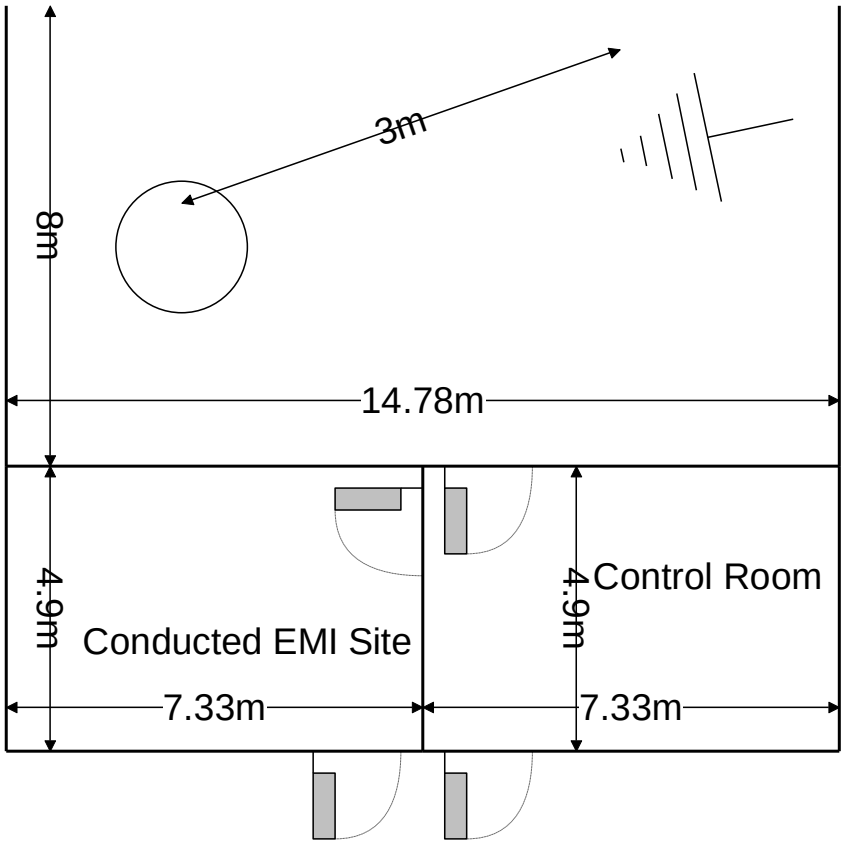

Figure 2.3.1-1: Semi-Anechoic Chamber Test Site

2.3.2 Conducted Emissions Test Site Description

The dimensions of the shielded conducted room are 7.3 x 4.9 x 3 m^3. As per ANSI C63.4 2003 requirements, the data were taken using two LISNs; a Solar Model 8028-50 50 Ω/50 µH and an EMCO Model 3825, which are installed as shown in Photograph 3. For 220 V, 50 Hz, a Polarad LISN (S/N 879341/048) is used in conjunction with a 1 kVA, 50 Hz/220 V EDGAR variable frequency generator, Model 1001B, to filter conducted noise from the generator.

A diagram of the room is shown below in figure 2.3.2-1:

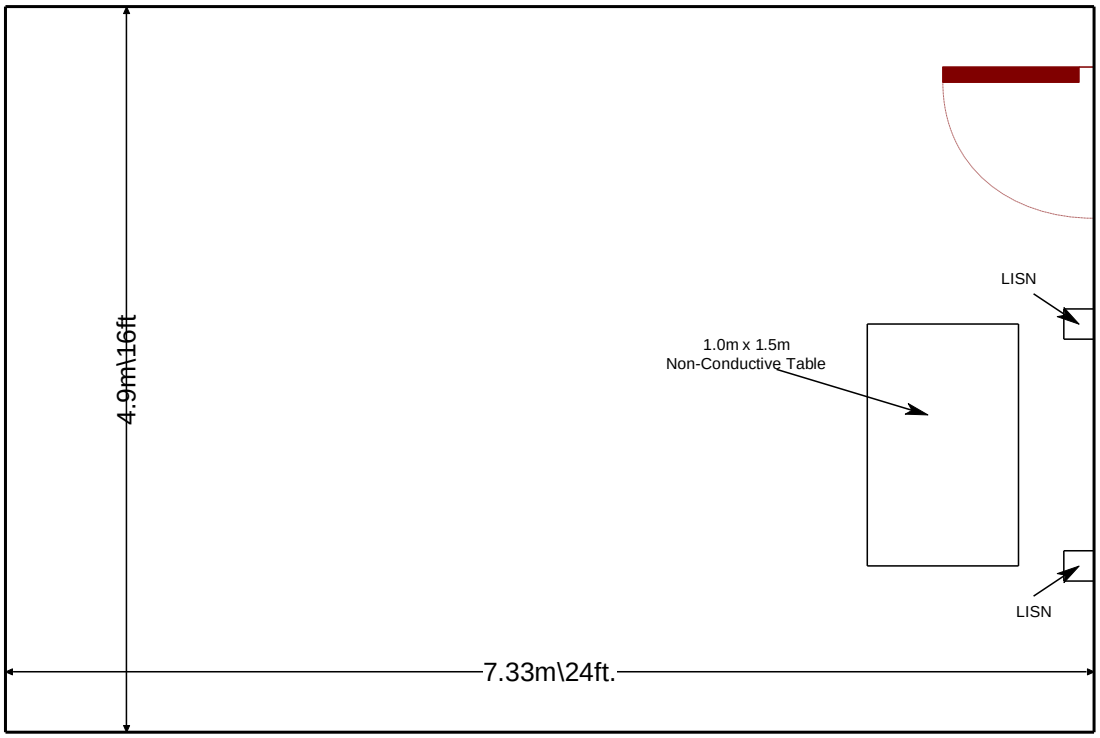

Figure 2.3.2-1: AC Mains Conducted EMI Site

3 APPLICABLE STANDARD REFERENCES

The following standards were used:

- ANSI C63.4-2003: Method of Measurements of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the 9KHz to 40GHz
- US Code of Federal Regulations (CFR): Title 47, Part 2, Subpart J: Equipment Authorization Procedures, 2012
- US Code of Federal Regulations (CFR): Title 47, Part 15, Subpart C: Radio Frequency Devices, Intentional Radiators, 2012
- KDB Publication No. 558074 – Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under 15.247, January 2012.
- 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 and Information for the Certification of Radiocommunication Equipment, Issue 3, December 2010.

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
523	Agilent	E7405	Spectrum Analyzers	MY45103293	1/5/2011	1/5/2013
524	Chase	CBL6111	Antennas	1138	1/7/2011	1/7/2013
2006	EMCO	3115	Antennas	2573	3/2/2011	3/2/2013
2008	COM-Power	AH-826	Antennas	81009	NCR	NCR
2011	Hewlett-Packard	HP 8447D	Amplifiers	2443A03952	1/2/2012	1/2/2013
2037	ACS Boca	Chamber EMI Cable Set	Cable Set	2037	1/2/2012	1/2/2013
2044	QMI	N/A	Cables	2044	1/2/2012	1/2/2013
2070	Mini Circuits	VHF-8400+	Filter	2070	1/19/2012	1/19/2013
2072	Mini Circuits	VHF-3100+	Filter	30737	1/19/2012	1/19/2013
2075	Hewlett Packard	8495B	Attenuators	2626A11012	1/2/2012	1/2/2013
2076	Hewlett Packard	HP5061-5458	Cables	2076	1/2/2012	1/2/2013
2082	Teledyne Storm Products	90-010-048	Cables	2082	6/6/2011	6/6/2012
2086	Merrimac	FAN-6-10K	Attenuators	23148-83-1	12/30/2011	12/30/2012
2091	Agilent Technologies, Inc.	8573A	Spectrum Analyzers	2407A03233	12/12/2011	12/12/2013
2095	ETS Lindgren	TILE4! - Version 4.2.A	Software	85242	NCR	NCR
RE586	Agilent Technologies, Inc.	83017A	Amplifiers	3123A00168	9/23/2011	9/23/2012

NCR=No Calibration Required

5 SUPPORT EQUIPMENT

Table 5-1: Support Equipment – Radiated Emissions

Item	Equipment Type	Manufacturer	Model Number	Serial Number
1	The unit was evaluated standalone with no support equipment			

6 EQUIPMENT UNDER TEST SETUP BLOCK DIAGRAM

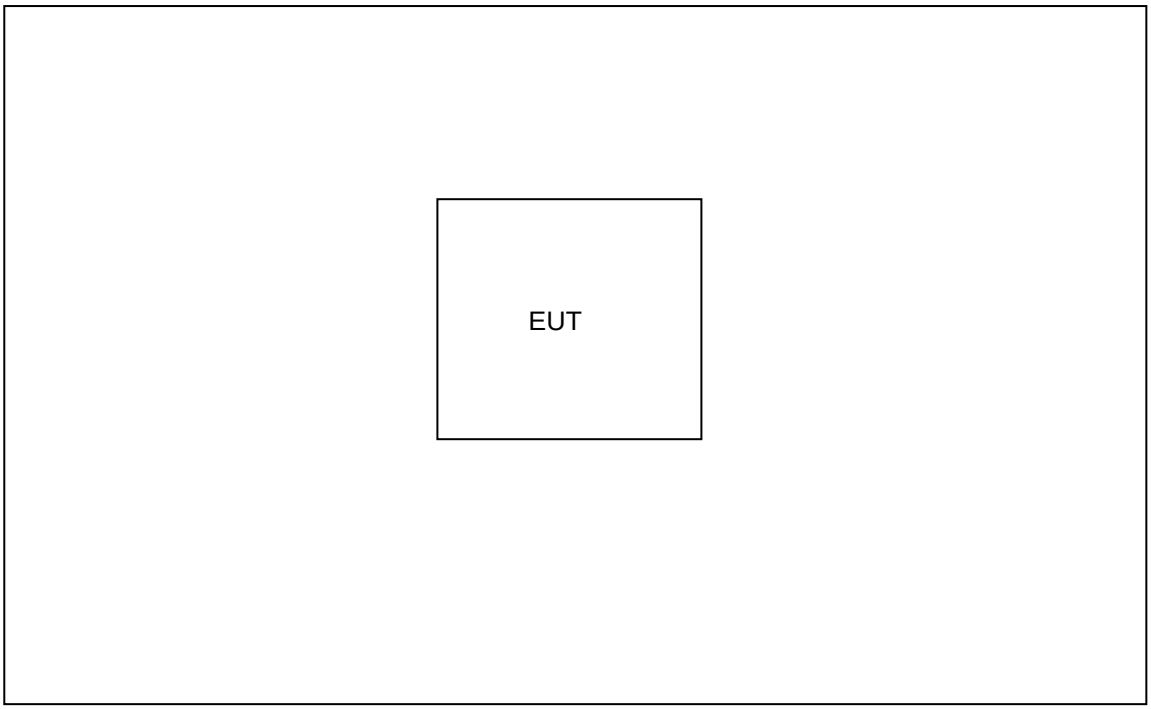

Figure 6-1: Test Setup – Radiated Emissions

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

The unit uses an internal 3 dBi Inverted-F PCB antenna, hence meeting the requirement of FCC Part 15, Section 15.203.

7.2 6 dB Bandwidth - FCC: Section 15.247(a)(2) 99% Bandwidth IC: RSS-210 A8.2(a)

7.2.1 Measurement Procedure

The 6dB bandwidth was measured in accordance with the FCC KDB Publication No. 558074 "Guidance for Performing Compliance Measurements on Digital Transmission Systems (47 CFR 15.247)". The RBW of the spectrum analyzer was set to 30 kHz and VBW 100 kHz. Span was set large enough to capture the entire emissions and >> RBW.

The 99% occupied bandwidth was measured with the spectrum analyzer span set to fully display the emission, including the emissions skirts. The RBW was to 1% of the span. 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.

7.2.2 Measurement Results

Results are shown below.

Table 7.2.2-1: 6dB / 99% Bandwidth

Frequency [MHz]	6dB Bandwidth [kHz]	99% Bandwidth (kHz)
2405	1710	2830
2440	1680	3000
2480	1700	2860

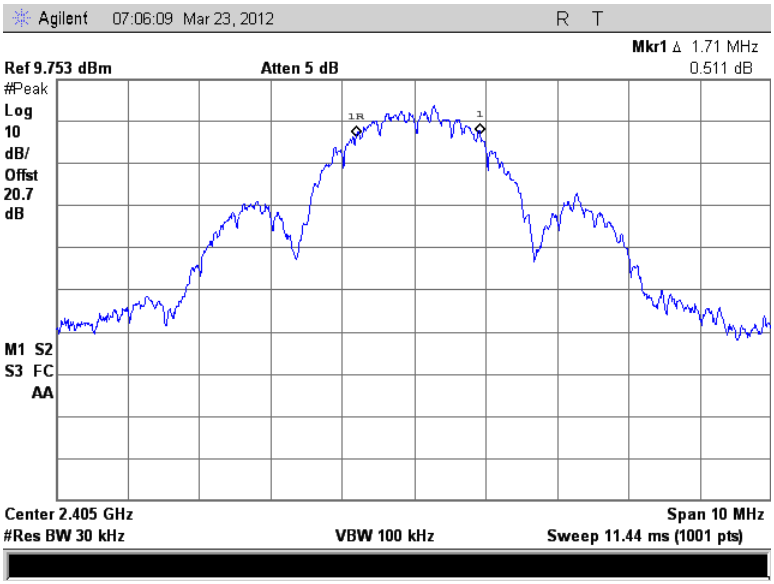

Figure 7.2.2-1: 6dB BW - Low Channel

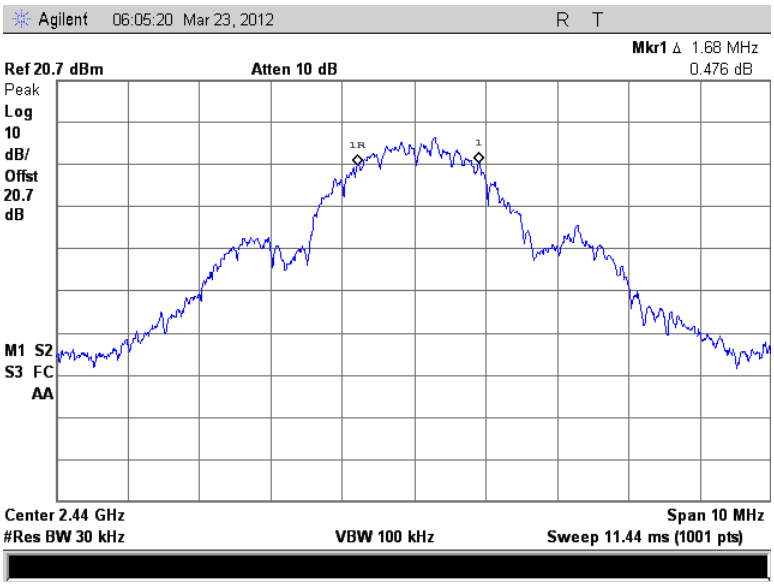

Figure 7.2.2-2: 6dB BW - Middle Channel

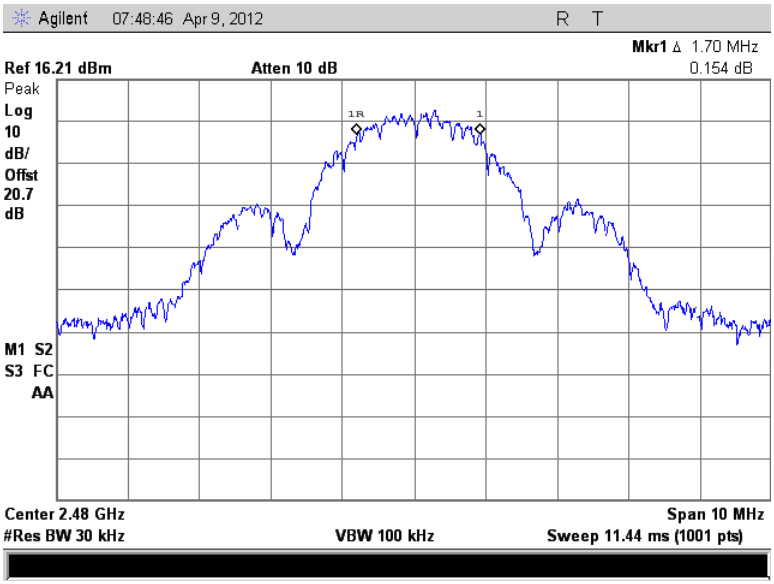

Figure 7.2.2-3: 6dB BW - High Channel

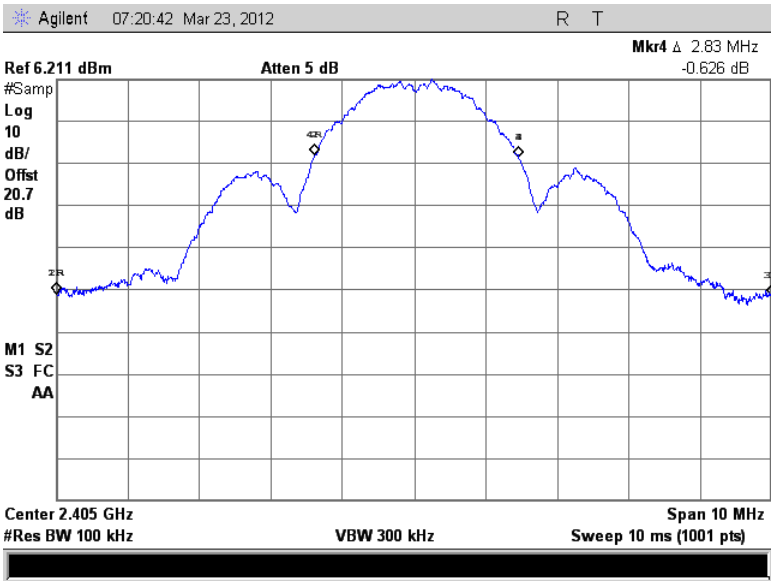

Figure 7.2.2-4: 99% OBW - Low Channel

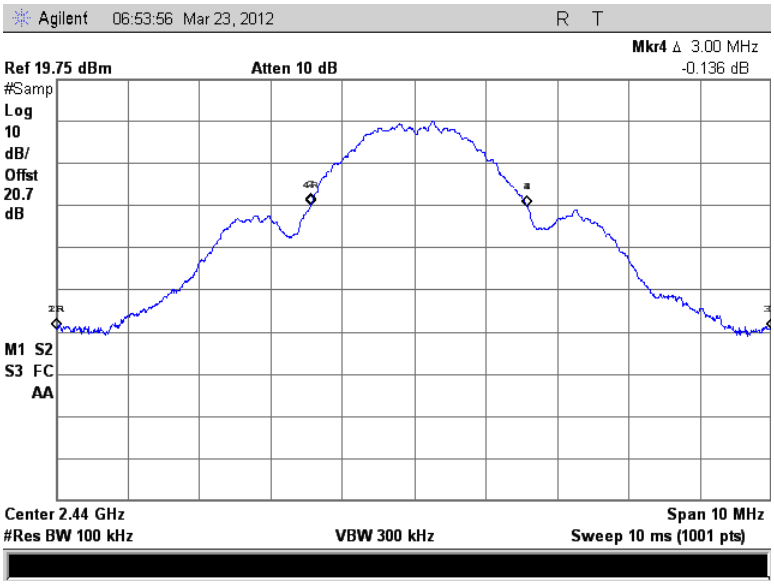

Figure 7.2.2-5: 99% OBW - Middle Channel

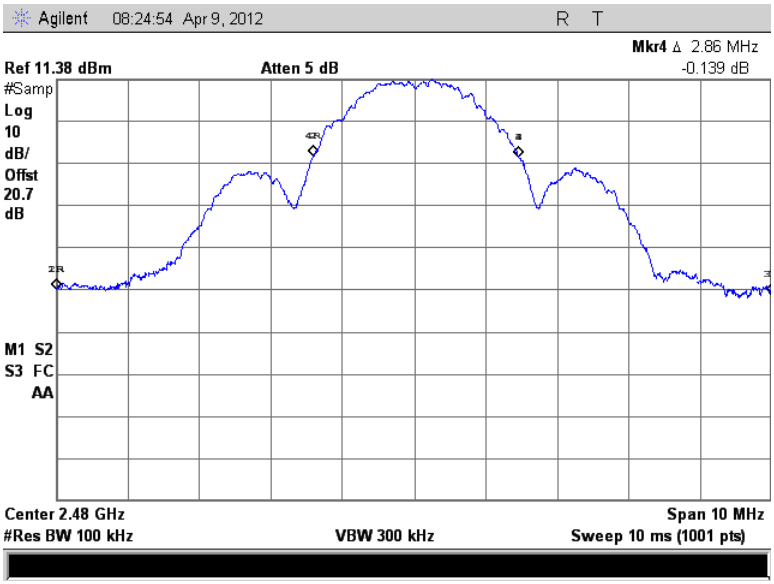

Figure 7.2.2-6: 99% OBW - High Channel

7.3 Peak Output Power - FCC Section 15.247(b)(3) IC: RSS-210 A8.4(4)

7.3.1 Measurement Procedure (Conducted Method)

The Peak Output Power was measured in accordance with the FCC KDB Publication No. 558074 "Guidance for Performing Compliance Measurements on Digital Transmission Systems (47 CFR 15.247)" Measurement Procedure PK2. The RF output of the equipment under test was directly connected to the input of the Spectrum Analyzer. Data was collected with the EUT operating at maximum power per channelization.

7.3.2 Measurement Results

Results are shown below.

Table 7.3.2-1: RF Output Power

Frequency [MHz]	Level [dBm]
2405	13.91
2440	15.70
2480	18.83

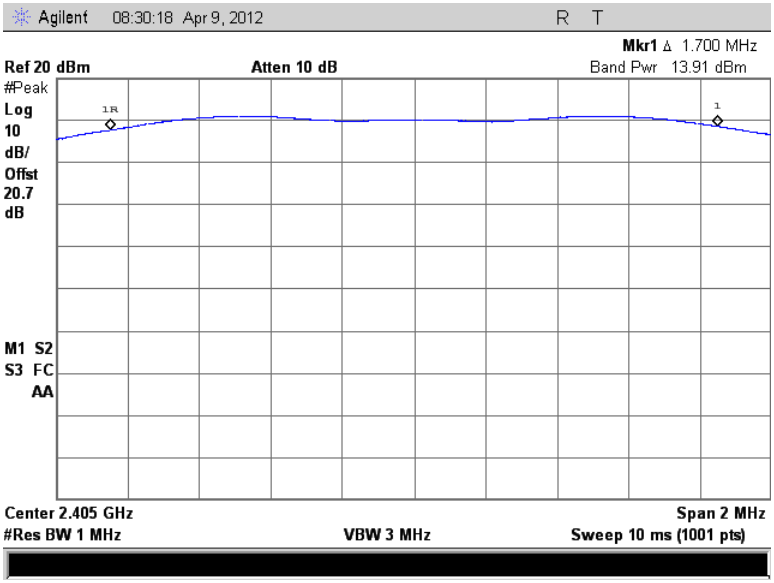

Figure 7.3.2-1: RF Output Power - Low Channel

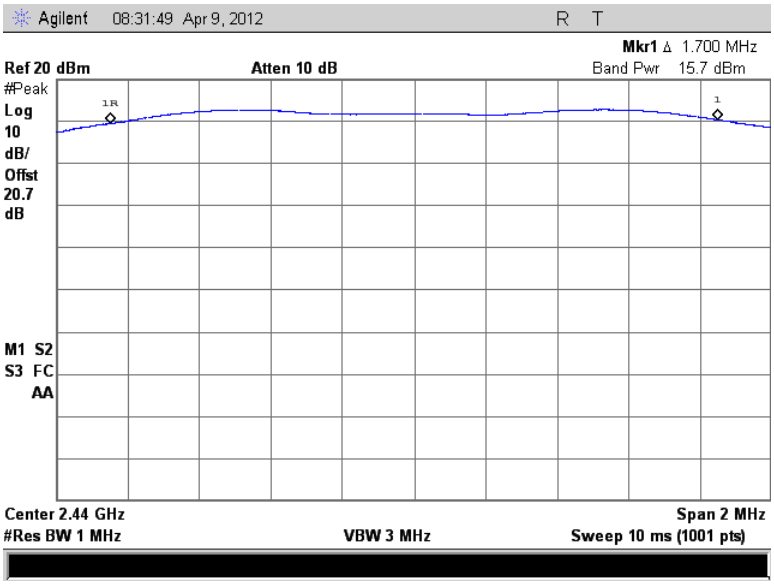

Figure 7.3.2-2: RF Output Power - Middle Channel

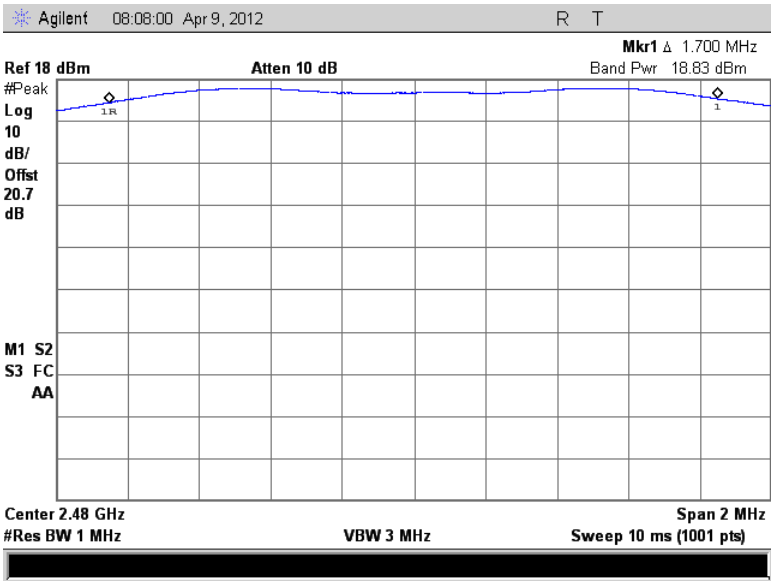

Figure 7.3.2-3: RF Output Power - High Channel

7.4 Band-Edge Compliance and Spurious Emissions-FCC 15.247(d) IC:RSS-210 A8.5

7.4.1 Band-Edge Compliance of RF Conducted Emissions

7.4.1.1 Measurement Procedure

The RF output port of the EUT was directly connected to the input of the spectrum analyzer via suitable attenuation. The EUT was investigated at the lowest and highest channel available to determine band-edge compliance. For each measurement the spectrum analyzer's RBW was set to 100 kHz, and the VBW was set to 300 kHz.

7.4.1.2 Measurement Results

Results are shown below.

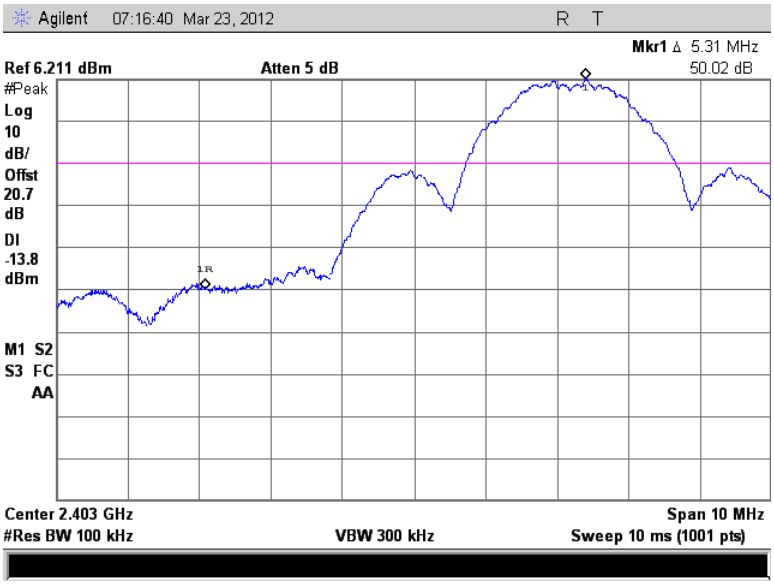

Figure 7.4.1.2-1: Lower Band-edge

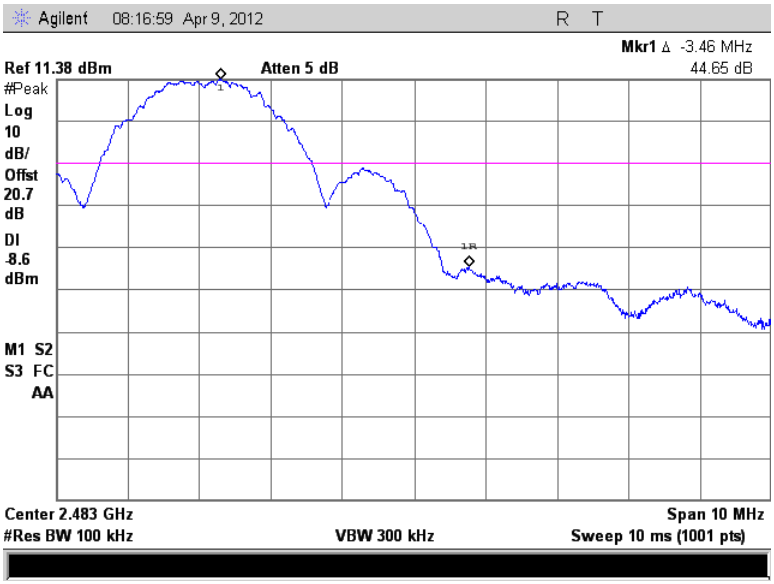

Figure 7.4.1.2-2: Upper Band-edge

7.4.2 Band-Edge Compliance of Radiated Emissions

7.4.2.1 Measurement Procedure

Because the upper band-edge coincides with a restricted band, band-edge compliance for the upper band-edge was determined using the radiated marker-delta method. The radiated field strength of the fundamental emission was first measured and then the marker-delta method was used to determine the field strength of the band-edge emission.

7.4.2.2 Measurement Results

Results are shown below.

Table 7.4.2.2-1: Upper Band-edge – Marker-Delta Method

Frequency (MHz)	Uncorrected Level (dBuV)		Antenna Polarity	Correction Factors	Fundamental Level (dBuV/m)		Marker-Delta (dB)	Band-Edge Level (dBuV/m)		Margin to Limits (dB)	
										74	54
	pk	Qpk/Avg	(H/V)	(dB)	pk	Qpk/Avg		pk	Qpk/Avg	pk	Qpk/Avg
2480	108.70	102.90	H	-9.92	98.78	56.73	44.25	54.53	12.48	19.47	41.52
2480	113.00	107.30	V	-9.92	103.08	61.13	43.33	59.75	17.80	14.25	36.20

Notes:
1. Delta Marker method at the upper band edge
2. A duty cycle correction of 20*log(1.54/100) = -36.25 dB was applied to the average measurements. The justification for the duty cycle is provided in the customer's theory of operation document.

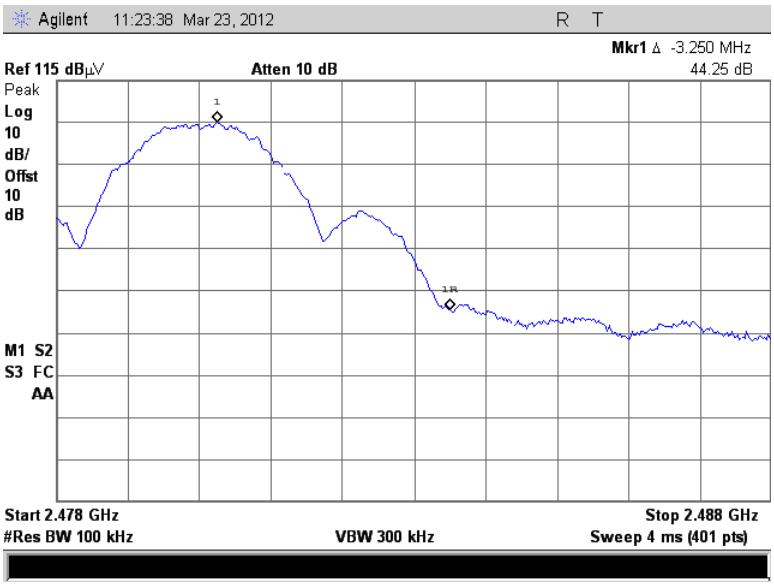

Figure 7.4.2.2-1: Upper Band-edge – Horizontal

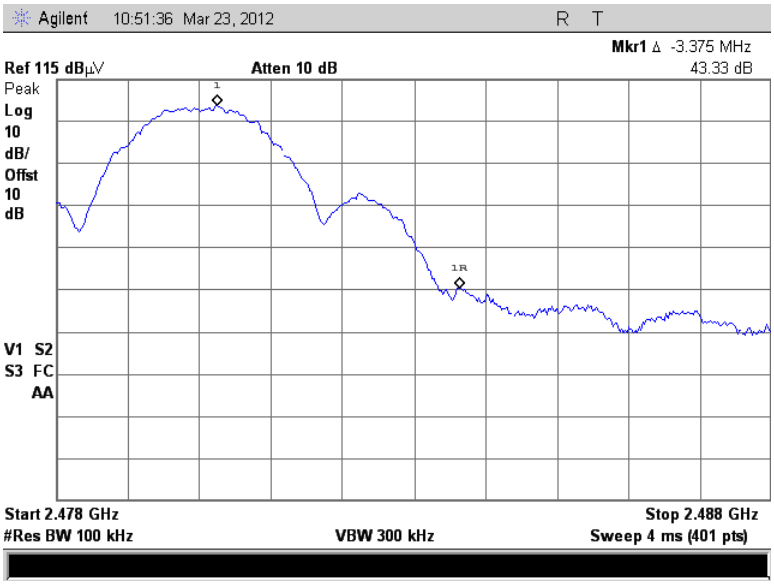

Figure 7.4.2.2-2: Upper Band-edge - Vertical

7.4.3 RF Conducted Spurious Emissions

7.4.3.1 Measurement Procedure

The RF Conducted Spurious Emissions were measured in accordance with the FCC KDB Publication No. 558074 "Guidance for Performing Compliance Measurements on Digital Transmission Systems (47 CFR 15.247)". The RF output port of the equipment under test was directly connected to the input of the spectrum analyzer. The EUT was investigated for conducted spurious emissions from 30MHz to 26 GHz, 10 times the highest fundamental frequency. Measurements were made at the low, center and high channels of the EUT. For each measurement, the spectrum analyzer's RBW was set to 100 kHz and the VBW was set to 300 kHz. The peak Max Hold function of the analyzer was utilized.

7.4.3.2 Measurement Results

Results are shown below.

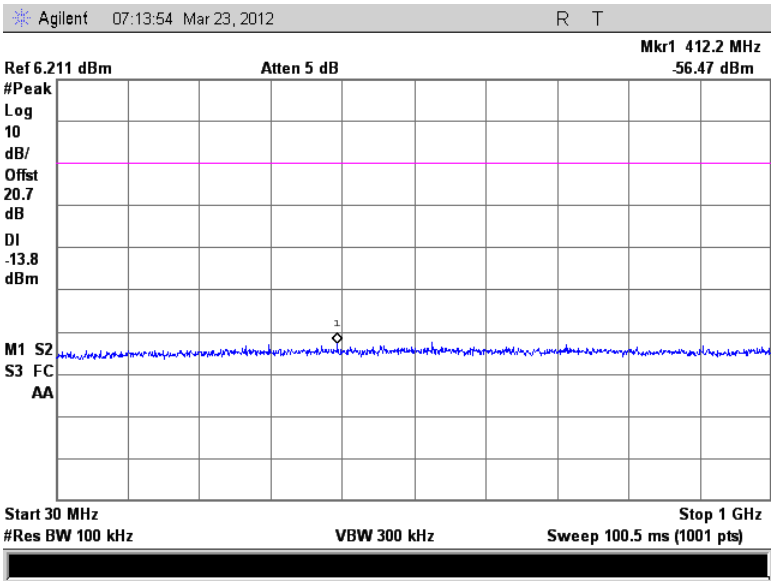

Figure 7.4.3.2-1: 30 MHz – 1 GHz – Low Channel

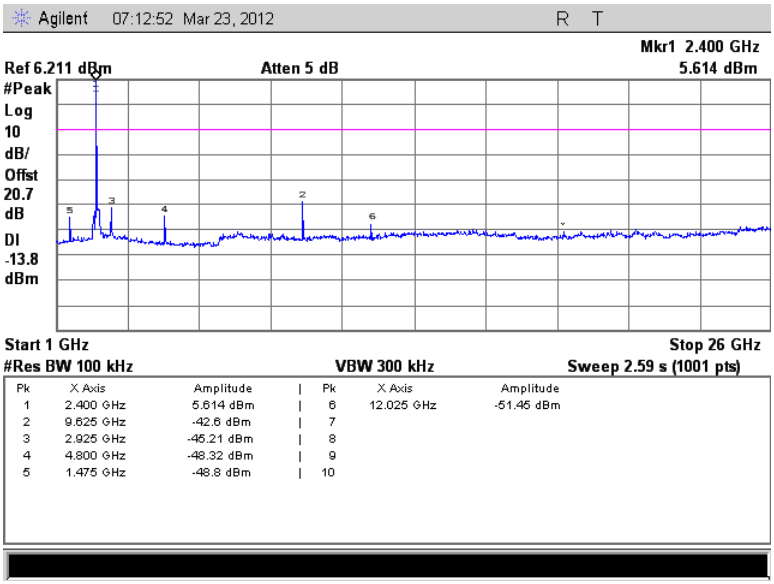

Figure 7.4.3.2-2: 1 GHz – 26 GHz – Low Channel

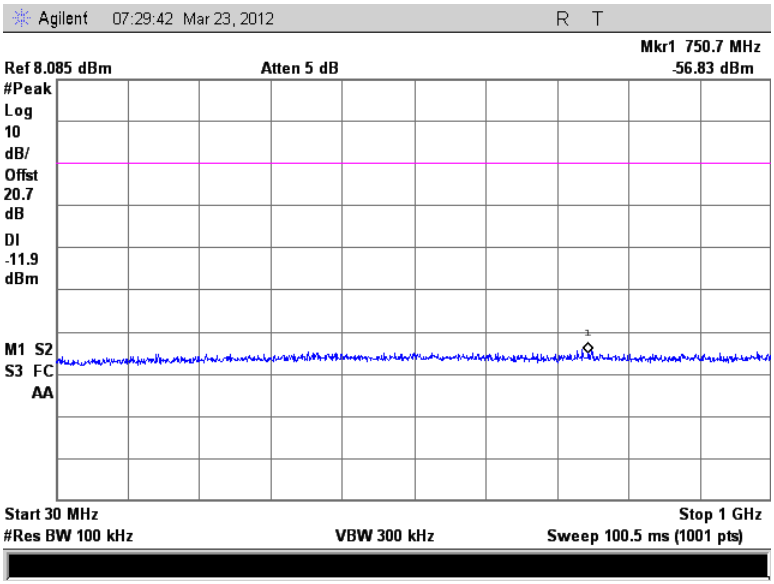

Figure 7.4.3.2-3: 30 MHz – 1 GHz –Middle Channel

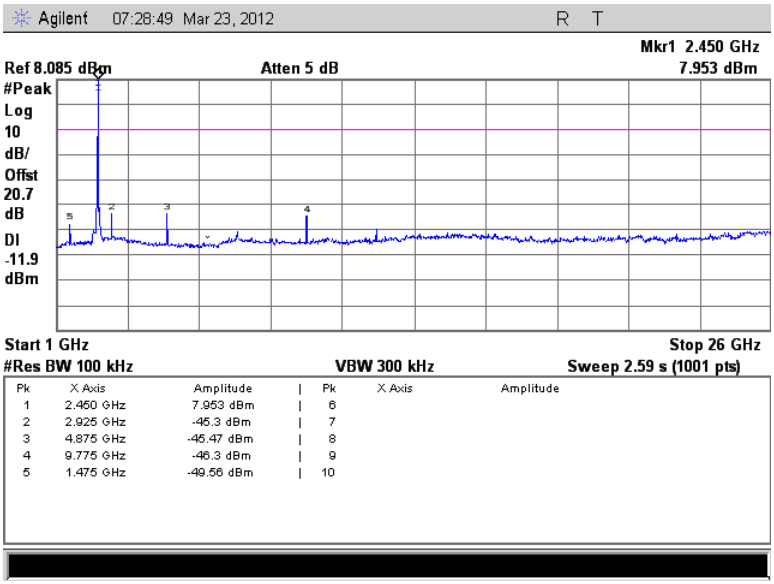

Figure 7.4.3.2-4: 1 GHz – 26 GHz – Middle Channel

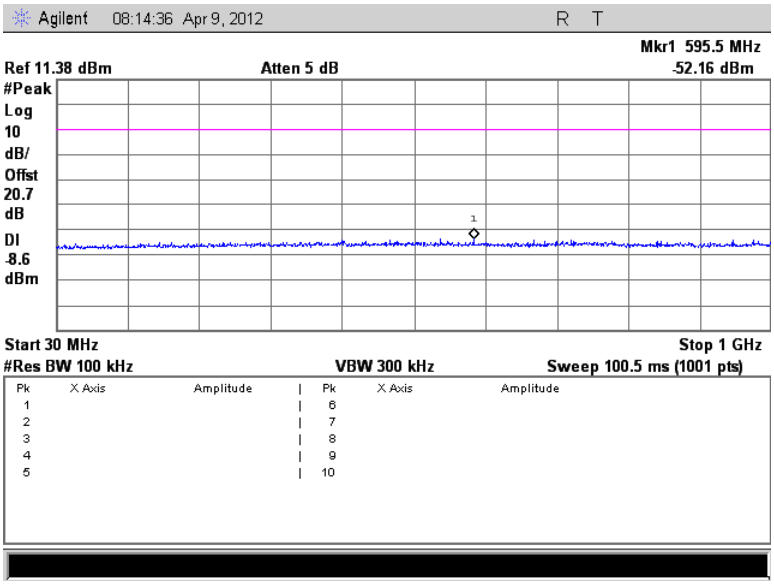

Figure 7.4.3.2-5: 30 MHz – 1 GHz – High Channel

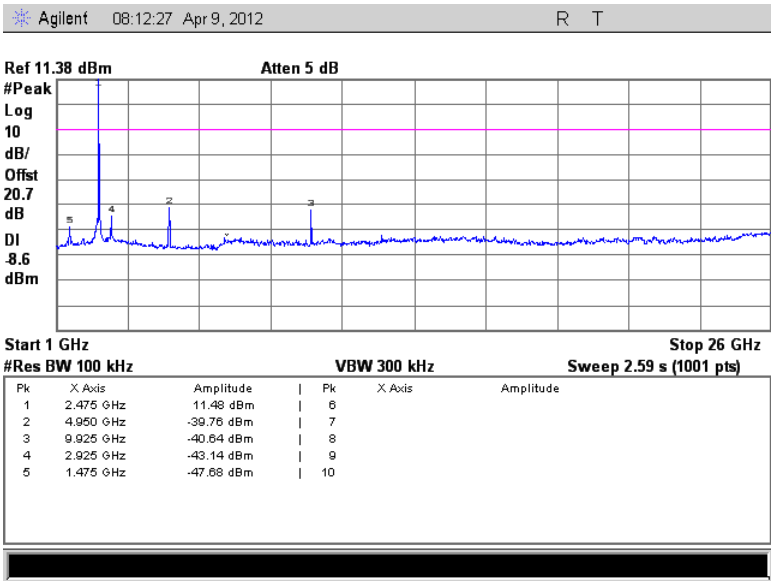

Figure 7.4.3.2-6: 1 GHz – 26 GHz –High Channel

7.4.4 Radiated Spurious Emissions - FCC Section 15.205 IC: RSS-210 2.2, RSS-GEN 7.2.5

7.4.4.1 Measurement Procedure

Radiated emissions tests were made over the frequency range of 30MHz to 26GHz, 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, quasi-peak measurements were made using a resolution bandwidth RBW of 120 kHz and a video bandwidth VBW of 300 kHz. For frequencies above 1000MHz, peak and average measurements made with RBW of 1 MHz and VBW of 3MHz and 10 Hz respectively.

Each emission found to be in a restricted band was compared to the applicable radiated limits. A duty cycle correction factor of 1.54% ≈ -36.25 dB was applied to the spurious emissions showing the same pulsing signatures as the fundamental. The justification for the correction is documented in the customer's theory of operation.

7.4.4.2 Measurement Results

Radiated spurious emissions found in the band of 30MHz to 26GHz are reported below.

Table 7.4.4.2-1: Radiated Spurious Emissions Tabulated Data

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
Low Channel 2405 MHz										
1464.2	75.09	61.93	V	-15.24	59.85	46.69	74.0	54.0	14.20	7.30
1464.2	71.63	58.26	H	-15.24	56.39	43.02	74.0	54.0	17.60	11.00
2390	62.62	50.71	V	-10.31	52.31	4.15	74.0	54.0	21.70	49.90
2498.89	68.67	53.56	V	-9.84	58.83	7.47	74.0	54.0	15.20	46.50
4810	55.07	46.29	H	-2.74	52.33	7.30	74.0	54.0	21.70	46.70
4810	55.39	47.78	V	-2.74	52.65	8.79	74.0	54.0	21.30	45.20
12025	58.40	48.50	H	9.66	68.06	21.91	83.5	63.5	15.40	41.60
12025	56.76	46.94	V	8.51	65.27	19.20	83.5	63.5	18.20	44.30
Middle Channel 2440 MHz										
1464.5	71.56	58.40	H	-15.24	56.32	43.16	74.0	54.0	17.70	10.80
1464.5	75.13	59.76	V	-15.24	59.89	44.52	74.0	54.0	14.10	9.50
2495.92	72.96	56.82	V	-9.85	63.11	10.72	74.0	54.0	10.90	43.30
4880	61.43	54.45	H	-2.55	58.88	15.65	74.0	54.0	15.10	38.40
4880	56.69	48.69	V	-2.55	54.14	9.89	74.0	54.0	19.90	44.10
7320	67.92	58.89	H	1.60	69.52	24.24	74.0	54.0	4.50	29.80
7320	65.54	57.00	V	1.60	67.14	22.35	74.0	54.0	6.90	31.60
12200	54.70	44.49	H	9.78	64.48	18.02	83.5	63.5	19.00	45.50
12200	54.67	44.78	V	8.36	63.03	16.89	83.5	63.5	20.50	46.60
19520	48.19	35.93	H	6.65	54.84	6.33	83.5	63.5	28.70	57.20
High Channel 2480 MMHz										
1463.45	72.02	58.80	H	-15.25	56.77	43.55	74.0	54.0	17.20	10.40
1463.45	69.74	55.74	V	-15.25	54.49	40.49	74.0	54.0	19.50	13.50
4922	53.61	34.28	H	-2.45	51.16	31.83	74.0	54.0	22.80	22.20
4922	53.03	33.78	V	-2.45	50.58	31.33	74.0	54.0	23.40	22.70
4960	60.69	53.39	H	-2.35	58.34	14.79	74.0	54.0	15.70	39.20
4960	58.13	50.35	V	-2.35	55.78	11.75	74.0	54.0	18.20	42.20
7440	58.07	48.38	H	1.98	60.05	14.11	74.0	54.0	14.00	39.90
7440	64.19	55.78	V	1.98	66.17	21.51	74.0	54.0	7.80	32.50

Note:

1. All emissions above 19520 MHz were attenuated below the noise floor of the measurement equipment and the limits.
2. A duty cycle correction of 1.54% is applied to the emissions demonstrating pulses similar to the fundamental.

7.4.4.3 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

Duty Cycle Correction Factor = 20*log(1.54/100) ≈ -36.25 dB

Example Calculation: Peak
Corrected Level: 62.62 -10.31 = 52.31 dBµV/m
Margin: 74 dBµV/m – 52.31 dBµV/m = 21.7dB

Example Calculation: Average
Corrected Level: 50.71 -10.31 - 36.25 = 4.15 dBµV/m
Margin: 54 dBµV/m – 4.15 dBµV/m = 49.9 dB

7.5 Power Spectral Density - FCC Section 15.247(e) IC: RSS-210 A8.2(b)

7.5.1 PSD Measurement Procedure (Conducted Method)

The power spectral density was measured in accordance with the FCC KDB Publication No. 558074 "Guidance for Performing Compliance Measurements on Digital Transmission Systems (47 CFR 15.247)" Measurement Procedure PKPSD. The RF output port of the EUT was directly connected to the input of the spectrum analyzer. Offset values were input for cable and attenuation. The spectrum analyzer RBW was set to 100 kHz and VBW 300 kHz. Span was adjusted to 5-30% of the 6 dB bandwidth and the sweep time was set to auto. The PSD was calculated by using the BWCF = 10*log(3 kHz/100kHz) = -15.2 dB.

7.5.2 Measurement Results

Results are shown below.

Table 7.5.2-1: RF Output Power

Frequency (MHz)	PSD/100kHz (dBm)	Correction Factor (dB)	PSD/3kHz (dBm)	Limit (dBm)	Margin (dB)
2405	6.211	15.2	-8.989	8	16.989
2440	8.085	15.2	-7.115	8	15.115
2480	11.38	15.2	-3.82	8	11.82

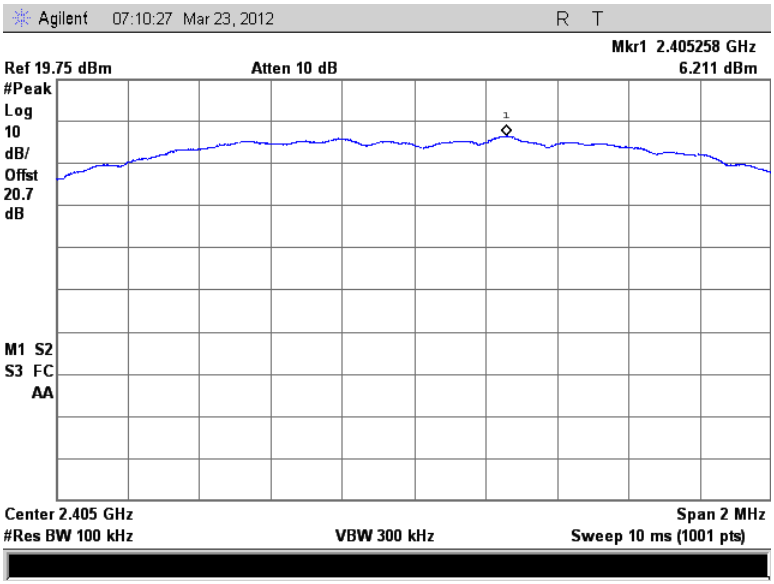

Figure 7.5.2-1: Power Spectral Density - Low Channel

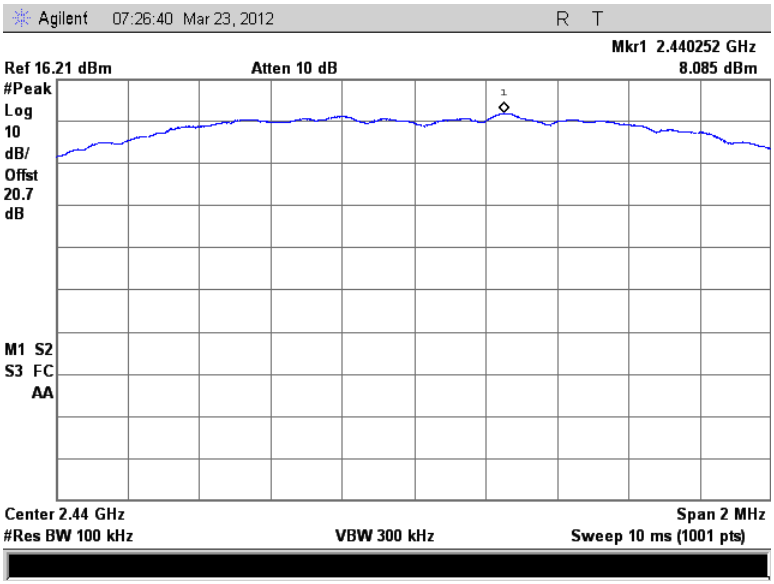

Figure 7.5.2-2: Power Spectral Density - Middle Channel

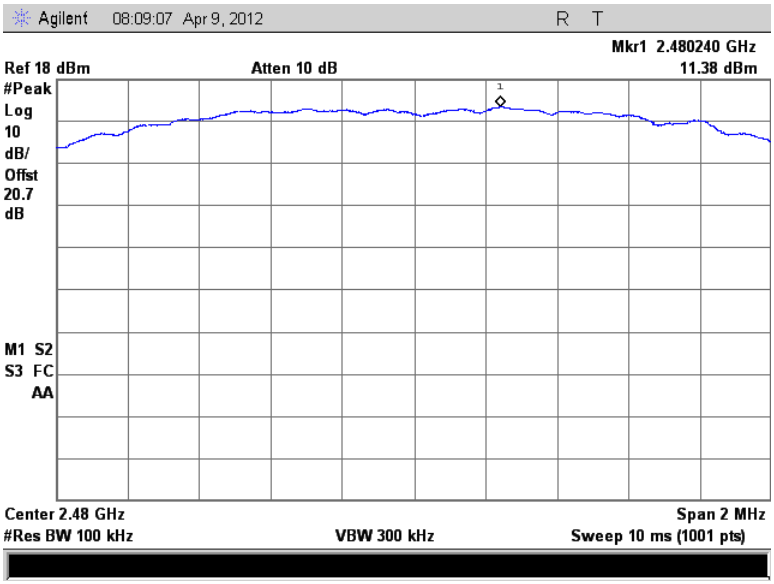

Figure 7.5.2-3: Power Spectral Density – High Channel

8 CONCLUSION

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

END REPORT