Excellence in Compliance Testing

Certification Test Report

FCC ID: AMH101002
IC: 10124A-101002

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

ACS Report Number: 12-2036.W06.1B

Manufacturer: Locus Solutions LLC
Model: SmartTraxx Fixed

Test Begin Date: **March 23, 2012**
Test End Date: **November 10, 2012**

Report Issue Date: December 7, 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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Reviewed by:

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

This report contains 31 pages

TABLE OF CONTENTS

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. SmartTraxx Fixed is a 2.4 GHz wireless transceiver with an external two way RF power divider at the RF port which feeds to a 1/4 wave dipole and a triband puck antenna. The unit also encloses a Quake Global Q4000 transceiver module which incorporates a GPS receiver and a Telit GSM wireless transceiver module (FCC ID:RI7GE865 / IC: 5131A-GE865).
The SmartTraxx Fixed is used to monitor shipment location, temperature and other conditions as well as shipment sensors. The SmartTraxx Fixed 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 - 2475 MHz
Number of Channels:	15
Modulation Format:	OQPSK
Antenna Type/Gain:	1/4 Wave Dipole Antenna, 2.15 dBi
	Puck Antenna, 1 dBi
Operating Voltage:	12 VDC

Manufacturer Information:

Locus Solutions LLC
14924 Corporate Rd S
Jupiter, FL 33478

Test Sample Serial Number(s): ACS #1

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

1.3 Test Methodology and Considerations

The Locus Solutions, Inc. SmartTraxx Fixed was programmed via Hyperterminal. The power settings were set to level 5 across the range of operation for the evaluation for both Radiated and RF conducted emissions measurements.

The RF conducted measurements were performed directly at the RF output of the unit, bypassing the splitter.

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 unit was also evaluated for collocation with the Telit wireless module for both the GSM 850 and the PCS 1900 bands. All intermodulation products for the collocated radios transmitting at the same time were found to be compliant to the limits of 15.209.

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:

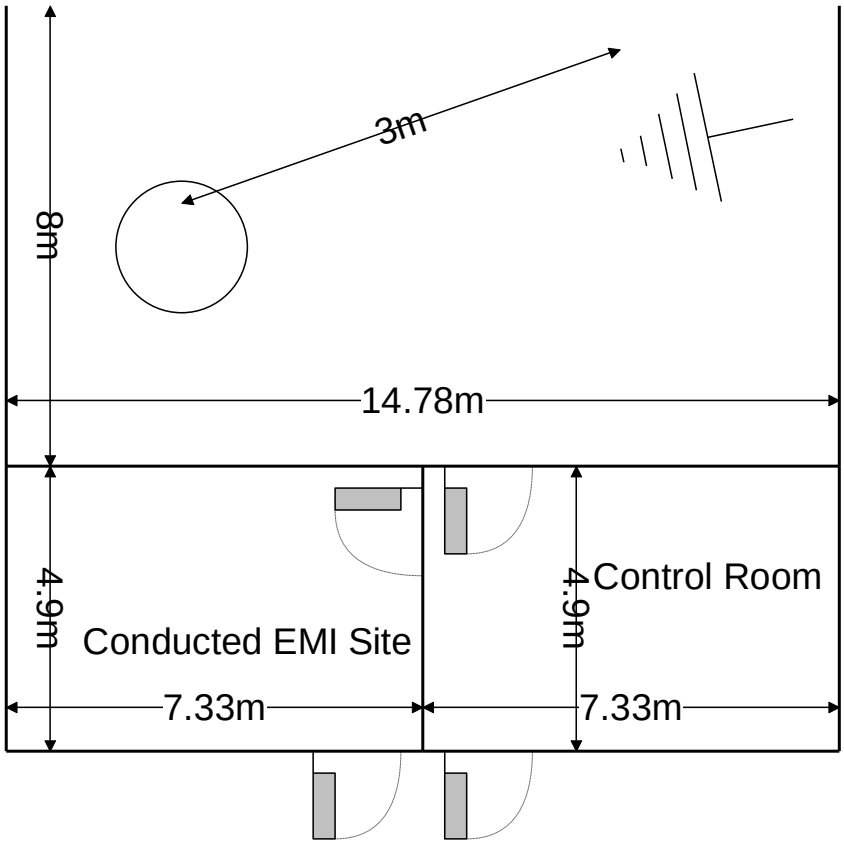

Figure 2.3.1-1: Semi-Anechoic Chamber Test Site

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:

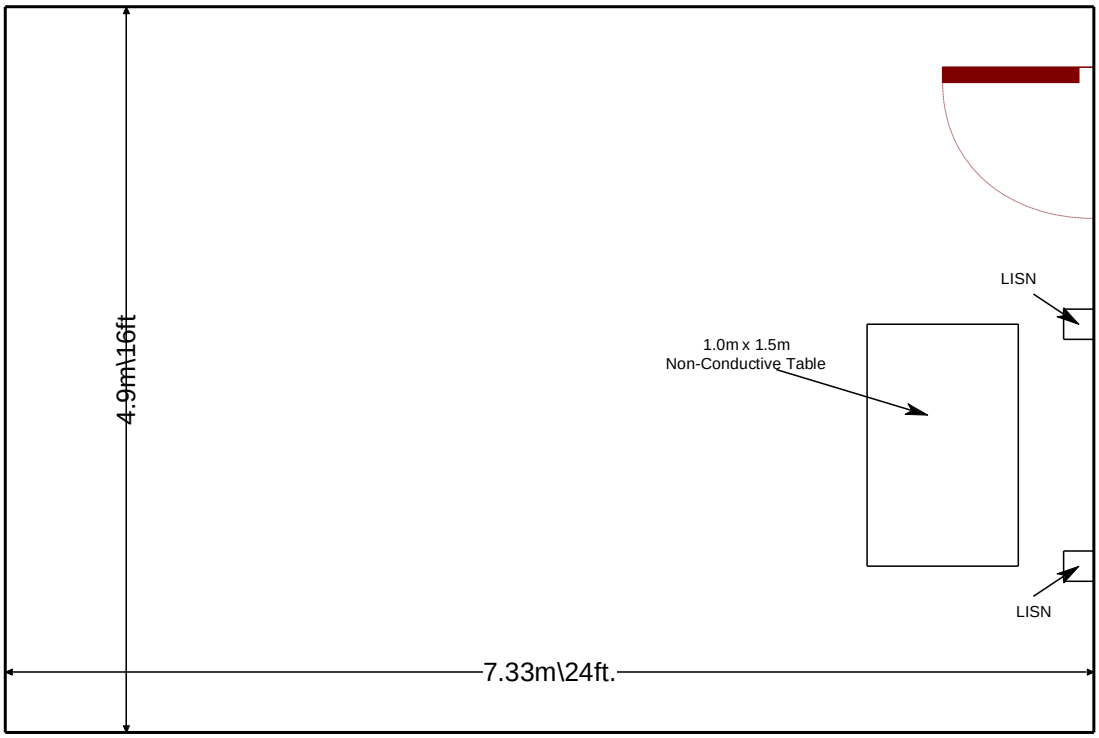

Figure 2.3.2-1: AC Mains Conducted EMI Site

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, October 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
2082	Teledyne Storm Products	90-010-048	Cables	2082	5/31/2012	5/31/2013
2086	Merrimac	FAN-6-10K	Attenuators	23148-83-1	12/30/2011	12/30/2012
2089	Agilent Technologies, Inc.	83017A	Amplifiers	3123A00214	12/22/2011	12/22/2012
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

Notes:

- **NCR=No Calibration Required**
- **The radiated emissions measurements above 1 GHz were performed with Assets 2089 and RE586, with the latter only being used within the active calibration period.**

5 SUPPORT EQUIPMENT

Table 5-1: Support Equipment

Item #	Type Device	Manufacturer	Model/Part #	Serial #
1	RF Power Splitter	In Stock Wireless Components	PD2120	N/A
2	Triband Antenna	SANAV	AW-4S	6101436
3	Dipole Antenna	AntennaFactor	ANT-2.4-CW-RCS	N/A
4	DC Power Supply	MPJA	HY5003	003700278

Table 5-2: Cable Description

Cable #	Cable Type	Length	Shield	Termination
A	Coaxial Cable	2.4m	Yes	Splitter to Triband Antenna
B	Coaxial Cable	2.4m	Yes	EUT to Triband Antenna
C	Coaxial Cable	2.4m	Yes	EUT to Triband Antenna
D	Coaxial Cable	1.52m	Yes	Splitter to Dipole Antenna
E	12 Wires Cable	0.5m	No	EUT to Banana Cables
F	2 x Banana Cables	0.95m	No	12 Wire Cable to Power Supply
G	Power Cord	2.5m	No	Power Supply to AC Main

6 EQUIPMENT UNDER TEST SETUP BLOCK DIAGRAM

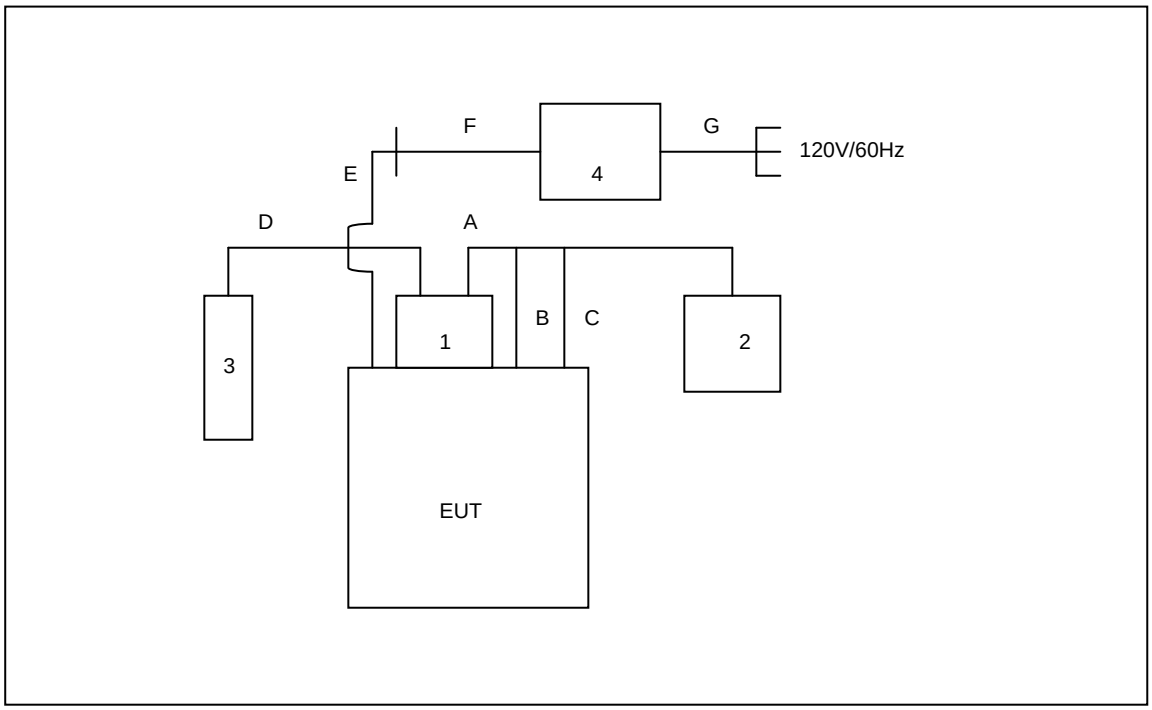

Figure 6-1: Test Setup – Radiated Emissions

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 SmartTraxx Fixed unit does not use a unique connector at the antenna port. However, per the customer, a professional antenna installer from Locus Traxx is required and used on all installations. To improve connection durability and enable tamper resilience, a silicone sealant is applied over the outer barrel of each electrical connection to and from the unit. Justification for professional installation is provided with this submission.

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	1495	3020
2440	1755	3220
2475	1665	3370

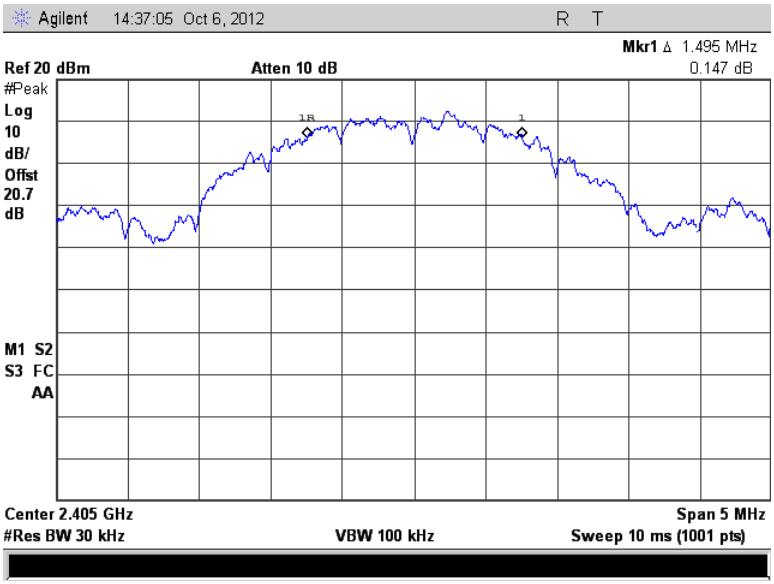

Figure 7.2.2-1: 6dB BW - Low Channel

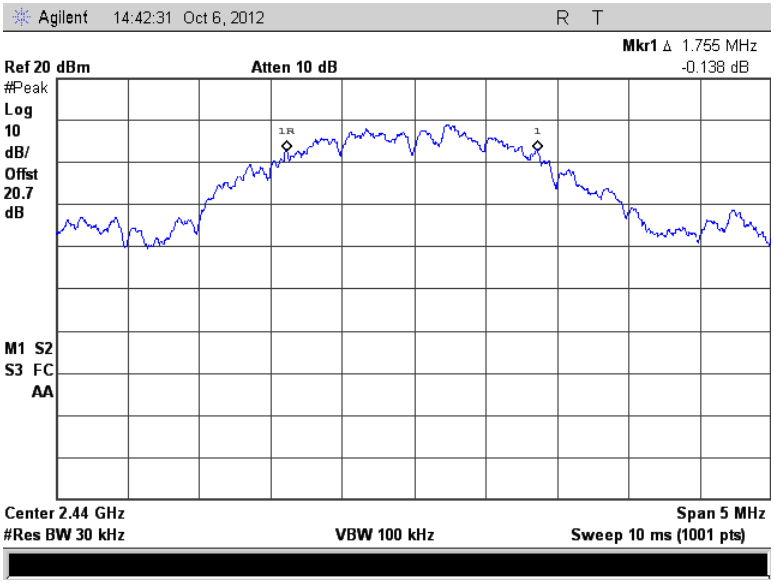

Figure 7.2.2-2: 6dB BW - Middle Channel

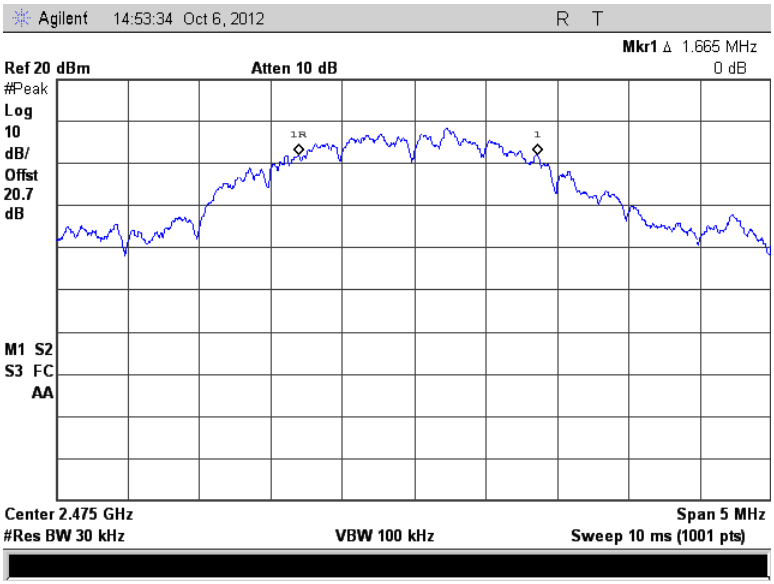

Figure 7.2.2-3: 6dB BW - High Channel

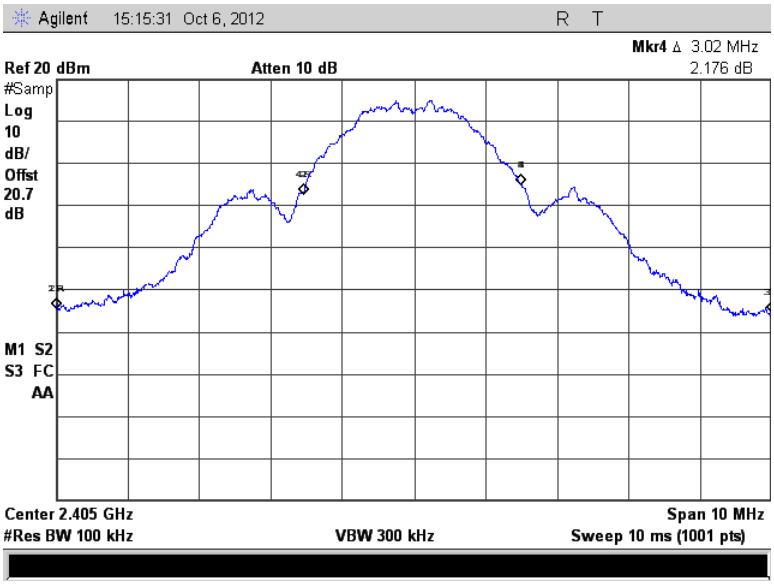

Figure 7.2.2-4: 99% OBW - Low Channel

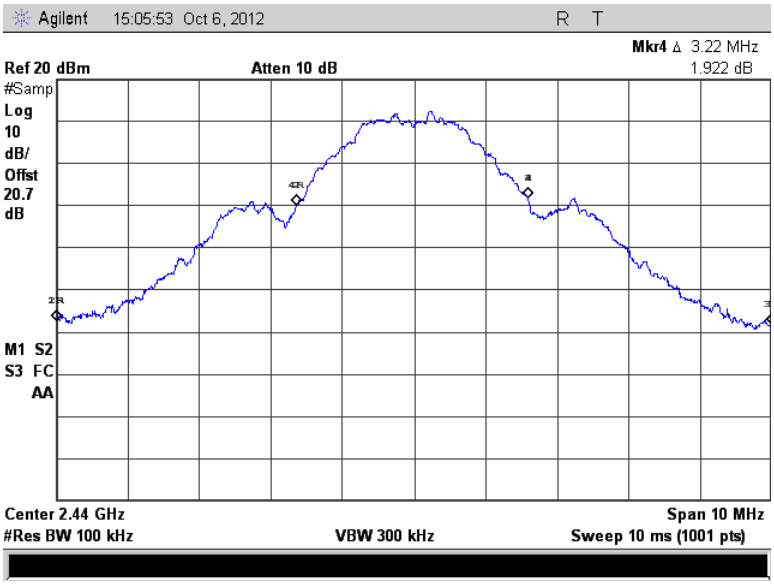

Figure 7.2.2-5: 99% OBW - Middle Channel

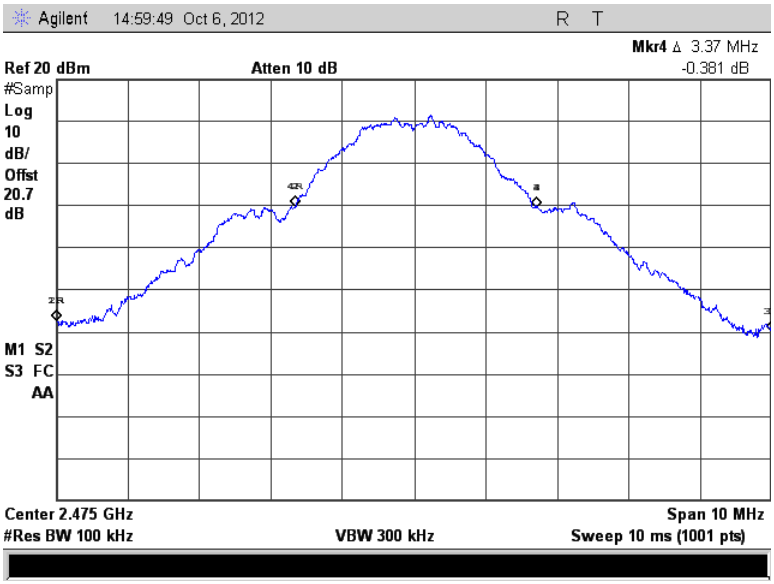

Figure 7.2.2-6: 99% OBW - High Channel

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)" Maximum Peak Conducted Output Power. The RF output of the equipment under test was directly connected to the input of the Spectrum Analyzer through suitable attenuation. 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	19.59
2440	17.23
2475	16.31

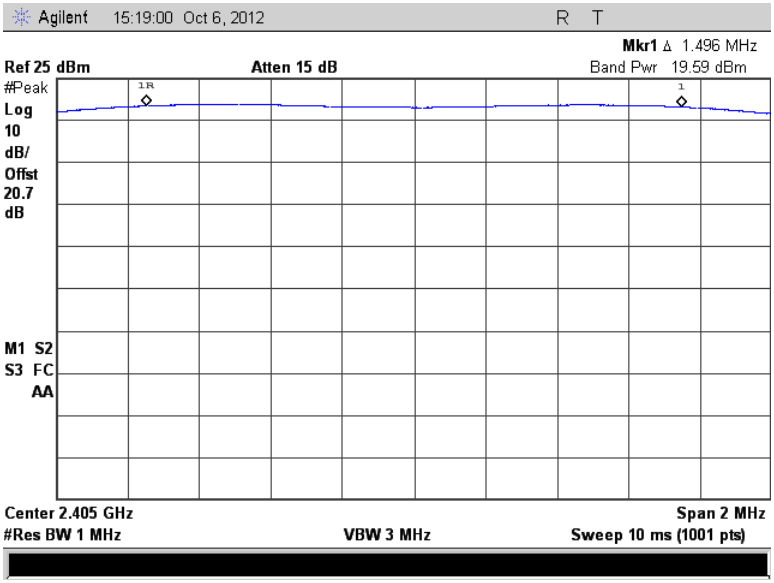

Figure 7.3.2-1: RF Output Power - Low Channel

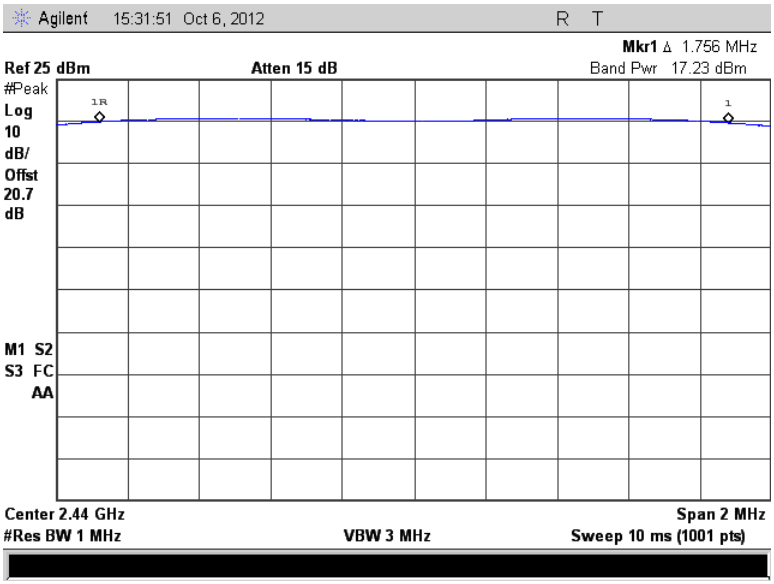

Figure 7.3.2-2: RF Output Power - Middle Channel

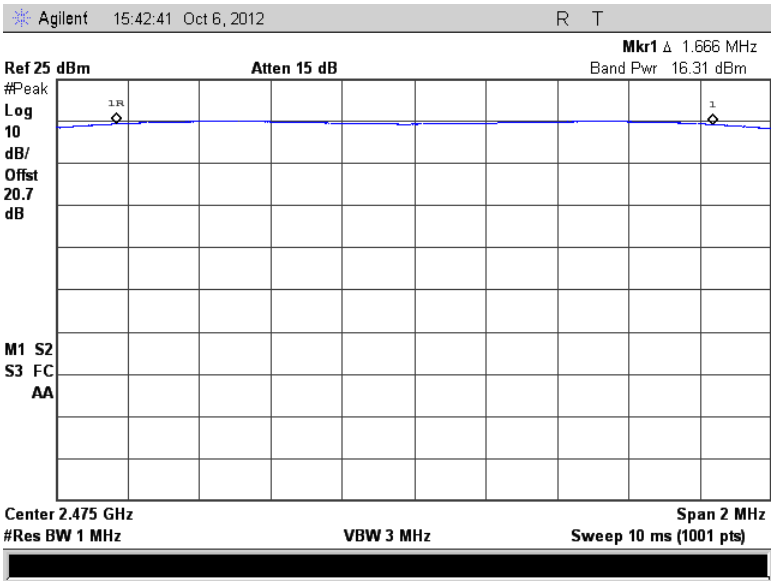

Figure 7.3.2-3: RF Output Power - High Channel

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.

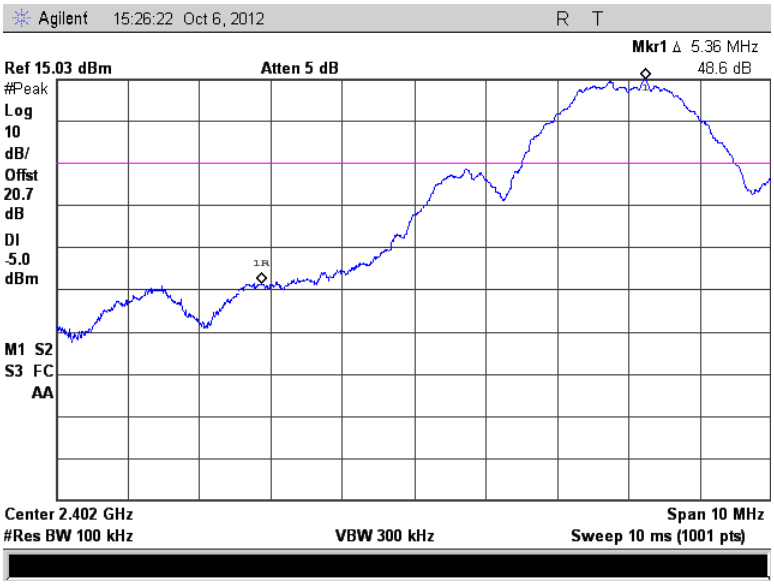

Figure 7.4.1.2-1: Lower Band-edge

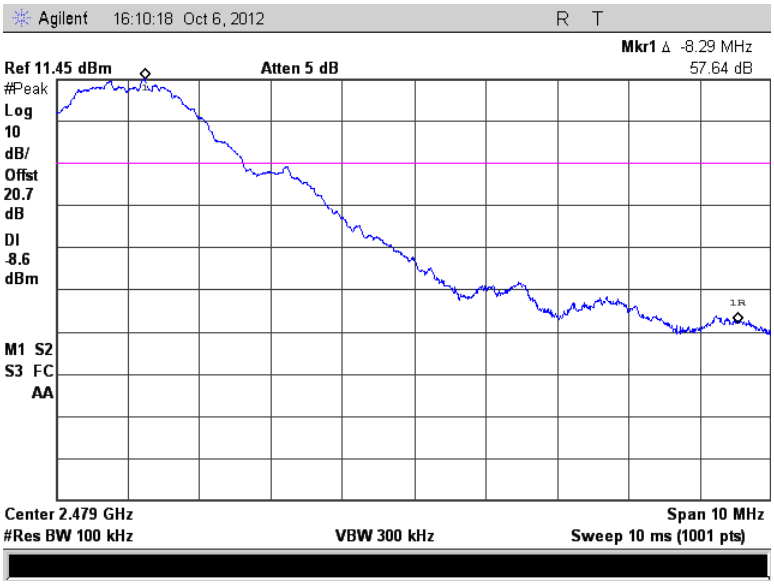

Figure 7.4.1.2-2: Upper Band-edge

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
2475	118.10	112.20	H	-9.94	108.16	66.01	55.39	52.77	10.62	21.23	43.38
2475	123.20	117.30	V	-9.94	113.26	71.11	56.75	56.51	14.36	17.49	39.64

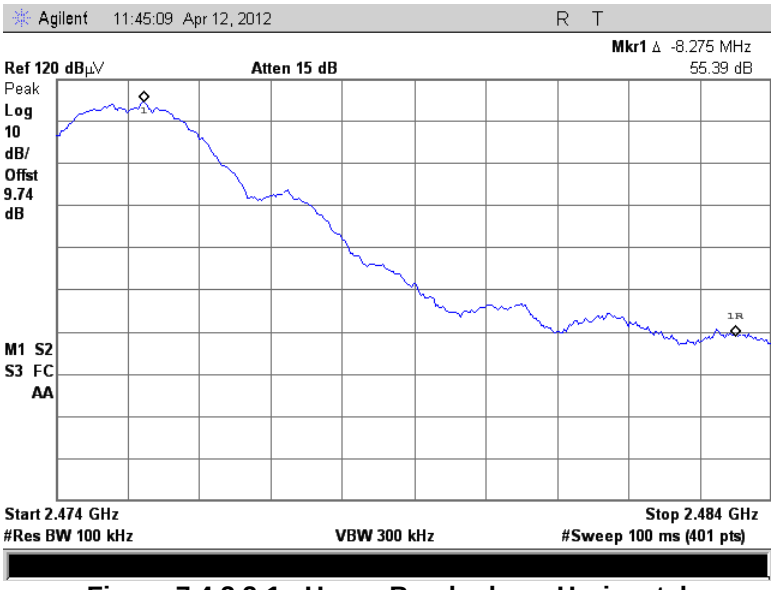

Figure 7.4.2.2-1: Upper Band-edge – Horizontal

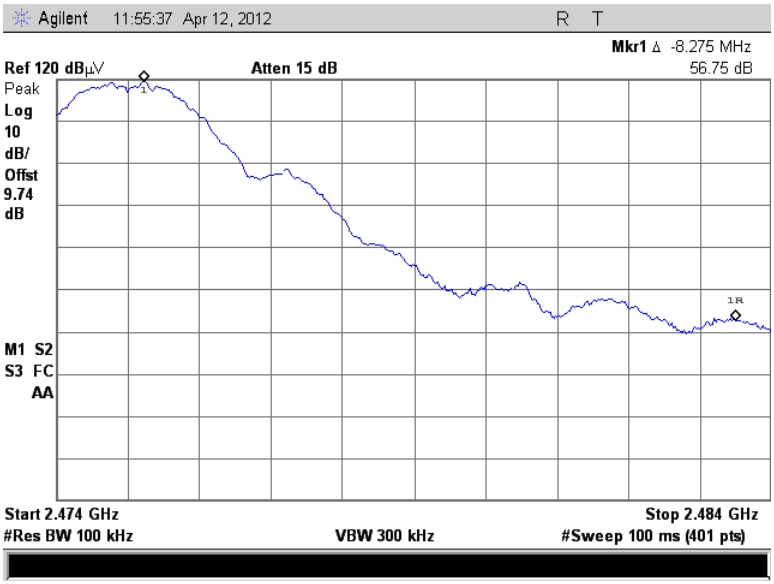

Figure 7.4.2.2-2: Upper Band-edge - Vertical

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.

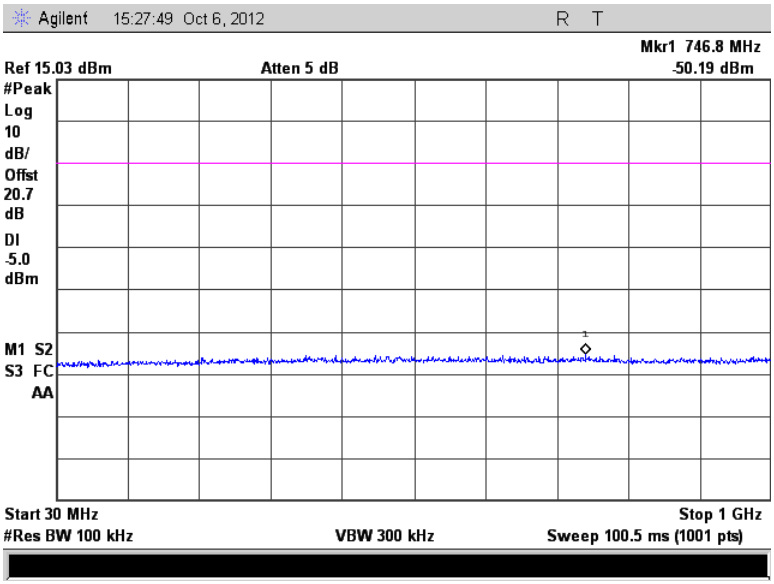

Figure 7.4.3.2-1: 30 MHz – 1 GHz – Low Channel

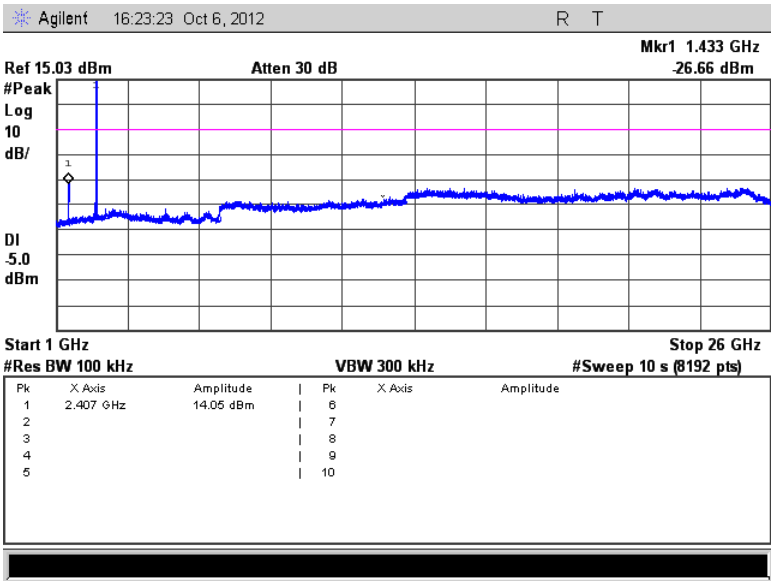

Figure 7.4.3.2-2: 1 GHz – 26 GHz – Low Channel

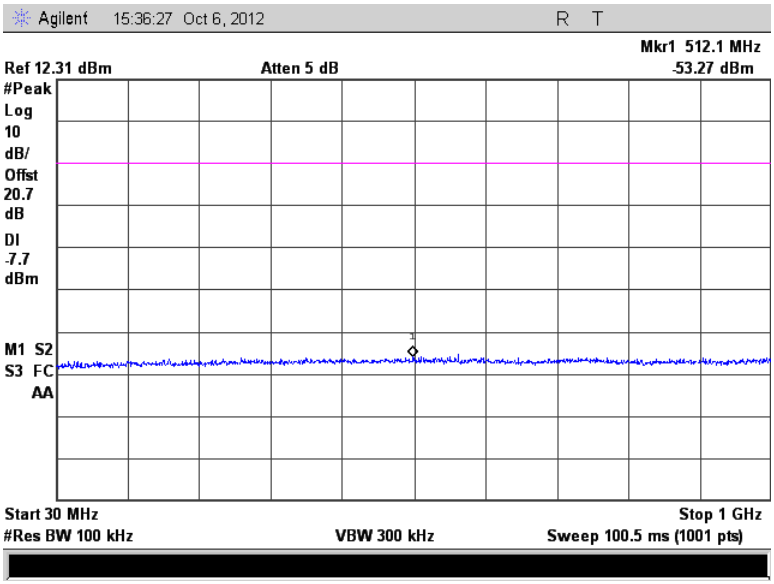

Figure 7.4.3.2-3: 30 MHz – 1 GHz –Middle Channel

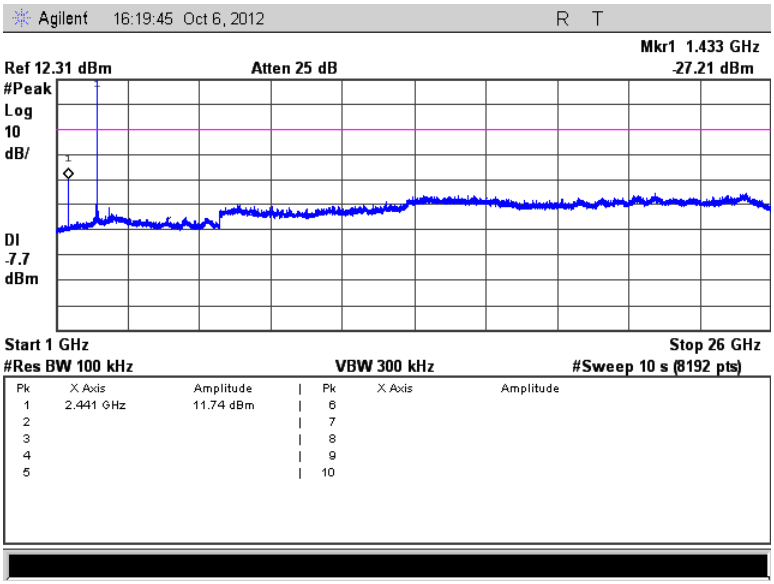

Figure 7.4.3.2-4: 1 GHz – 26 GHz – Middle Channel

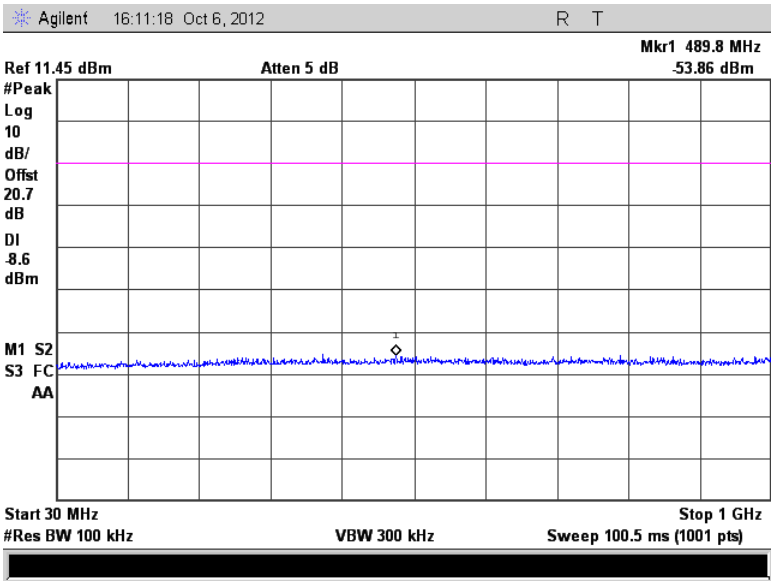

Figure 7.4.3.2-5: 30 MHz – 1 GHz – High Channel

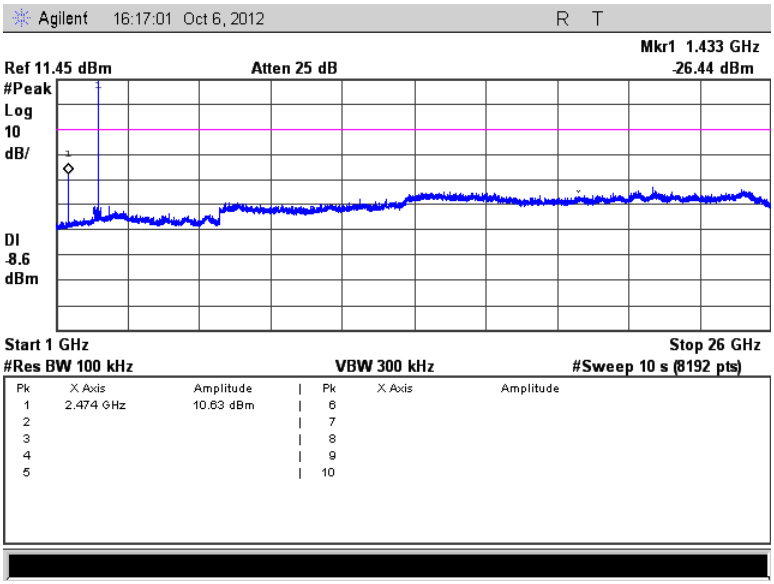

Figure 7.4.3.2-6: 1 GHz – 26 GHz –High Channel

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 1.476% ≈ -36.62 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)										
1424.5	76.94	63.91	V	-15.55	61.39	48.36	74.0	54.0	12.6	5.6
1424.825	78.86	65.76	H	-15.54	63.32	50.22	74.0	54.0	10.7	3.8
4810	61.36	54.00	H	-2.74	58.62	14.64	74.0	54.0	15.4	39.4
4810	62.39	55.77	V	-2.74	59.65	16.41	74.0	54.0	14.3	37.6
12025	55.82	44.95	H	9.66	65.48	17.99	83.5	63.5	18.0	45.5
12025	56.02	45.25	V	9.66	65.68	18.29	83.5	63.5	17.8	45.2
Middle Channel (2440 MHz)										
1425.575	77.67	64.51	H	-15.54	62.13	48.97	74.0	54.0	11.9	5.0
1425.575	75.69	62.76	V	-15.54	60.15	47.22	74.0	54.0	13.8	6.8
4880	61.39	54.58	H	-2.55	58.84	15.41	74.0	54.0	15.20	38.60
4880	68.47	62.00	V	-2.55	65.92	22.83	74.0	54.0	8.10	31.20
7320	62.03	53.20	H	1.60	63.63	18.18	74.0	54.0	10.40	35.80
7320	67.15	58.64	V	1.60	68.75	23.62	74.0	54.0	5.20	30.40
12200	55.04	42.75	H	9.78	64.82	15.91	83.5	63.5	18.70	47.60
12200	53.57	42.52	V	9.78	63.35	15.68	83.5	63.5	20.10	47.80
High Channel (2475 MHz)										
1423.235	75.46	62.65	H	-15.56	59.90	47.09	74.0	54.0	14.1	6.9
1423.35	75.11	62.17	V	-15.55	59.56	46.62	74.0	54.0	14.4	7.4
2483.5	69.10	54.03	H	-9.91	59.19	7.50	74.0	54.0	14.8	46.5
2483.5	73.31	58.03	V	-9.91	63.40	11.50	74.0	54.0	10.6	42.5
4950	62.45	55.77	H	-2.37	60.08	16.78	74.0	54.0	13.9	37.2
4950	64.39	57.84	V	-2.37	62.02	18.85	74.0	54.0	12.0	35.2
7425	60.88	52.03	H	1.93	62.81	17.34	74.0	54.0	11.2	36.7
7425	70.50	62.23	V	1.93	72.43	27.54	74.0	54.0	1.6	26.5
12375	53.67	42.97	H	9.91	63.58	16.26	83.5	63.5	19.9	47.2
12375	54.36	43.35	V	9.91	64.27	16.64	83.5	63.5	19.2	46.9
19800	46.08	32.85	V	7.59	53.67	3.82	83.5	63.5	29.8	59.7
22275	44.13	31.38	V	8.78	52.91	3.54	83.5	63.5	30.6	60.0

*Notes:

- All emissions above 22275 MHz were attenuated below the limits and the noise floor of the measurement equipment.
- Then emissions above 10 GHz were performed at 1m distance and the limits were corrected using a distance factor of 20*log(3/1) dB ≈ 9.54 dB.
- The average measurements were further corrected using a duty cycle correction factor of 20*log(1.476/100) dB ≈ -36.62 dB.
- The emissions at 1.4 GHz do not show pulsing signatures similar to the fundamental. Therefore, no duty cycle factor was applied to these measurements.

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(1.476/100) ≈ -36.62 dB

Example Calculation: Peak
Corrected Level: 61.36 -2.74 = 58.62 dBµV/m
Margin: 74 dBµV/m – 58.62 dBµV/m = 15.4dB

Example Calculation: Average
Corrected Level: 54 -2.74 - 36.62 = 14.64 dBµV/m
Margin: 54 dBµV/m – 14.64 dBµV/m = 39.4 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 Option. 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 3 kHz and VBW 10 kHz. Span was adjusted to 1.5 times the 6 dB bandwidth and the sweep time was set to auto.

7.5.2 Measurement Results

Results are shown below.

Table 7.5.2-1: Power Spectral Density

Frequency (MHz)	PSD/3kHz (dBm)	Limit (dBm)	Margin (dB)
2405	5.888	8.0	2.112
2440	3.308	8.0	4.692
2475	2.19	8.0	5.81

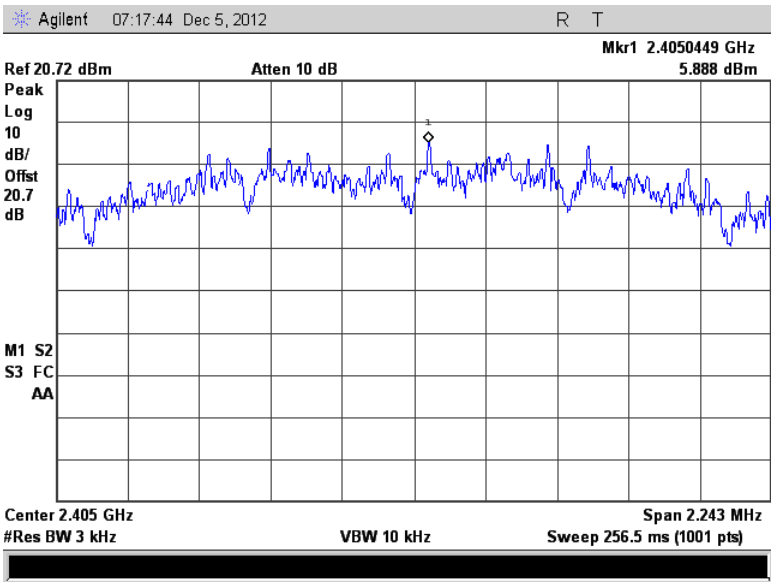

Figure 7.5.2-1: Power Spectral Density - Low Channel

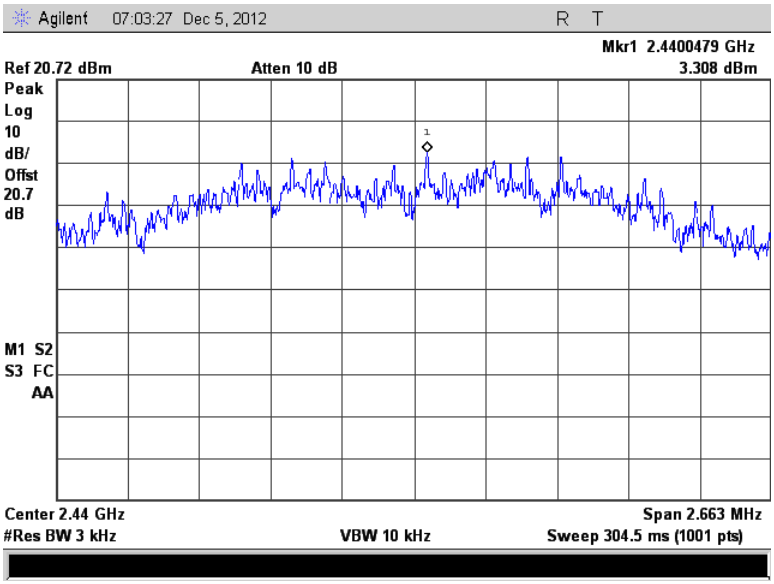

Figure 7.5.2-2: Power Spectral Density - Middle Channel

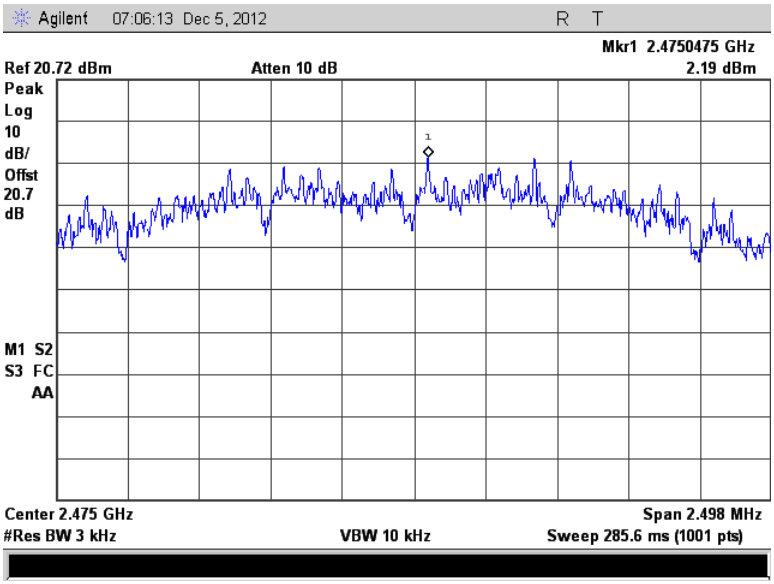

Figure 7.5.2-3: Power Spectral Density – High Channel

8 CONCLUSION

In the opinion of ACS, Inc. the SmartTraxx Fixed, 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