Excellence in Compliance Testing

Certification Test Report

FCC ID: U9O-RF200A
IC: 7084A-RF200A

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

ACS Report Number: 13-2096.W06.1A

Manufacturer: Synapse Wireless, Inc.
Model: RF200A

Test Begin Date: **July 9, 2013**
Test End Date: **July 19, 2013**

Report Issue Date: August 7, 2013

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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This report contains 43 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 for a modular approval.

1.2 Product description

The Synapse Wireless RF200A Module is an IEEE 802.15.4 compliant wireless mesh network module operating in the 2.4 GHz ISM band.

Technical Information:

Band of Operation:	2405 MHz - 2480 MHz
Number of Channels:	16
Modulation Format:	O-QPSK
Antenna Type/Gain:	Dipole Antenna, 3.2 dBi
	Printed Inverted-F Antenna, 0 dBi
Operating Voltage:	2.7 VDC - 3.6 VDC

Manufacturer Information:

Synapse Wireless Inc
500 Discovery Dr
Huntsville, AL 35806

Test Sample Serial Number(s): 536B69 (RSMA connector), 536368 (Inverted-F Antenna)

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

1.3 Test Methodology and Considerations

The model RF200A was evaluated for both RSMA Dipole and Inverted-F antenna configurations. The unit was powered through an evaluation board.

The RF conducted measurements were performed at the RSMA antenna port. The radiated emissions evaluations were performed with the EUT set in three orthogonal orientations for both antenna configurations and the data is reported for the worst case.

The RF output power had to be reduced at the highest and next to the highest operating frequency in order for the unit to meet the radiated band-edge requirements. The power settings used for the evaluation across the range of operation are listed below:

Channel 0 (2405 MHz): Power 6
Channel 7 (2440 MHz): Power 6
Channel 14 (2475 MHz): Power 11
Channel 15 (2480 MHz): Power 15.

The model RF200A was evaluated for power line emissions for both Dipole and PCB antenna configurations. The worst case results are reported in this document.

The EUT was also evaluated for unintentional emissions. The results are 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 #: 475089
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:

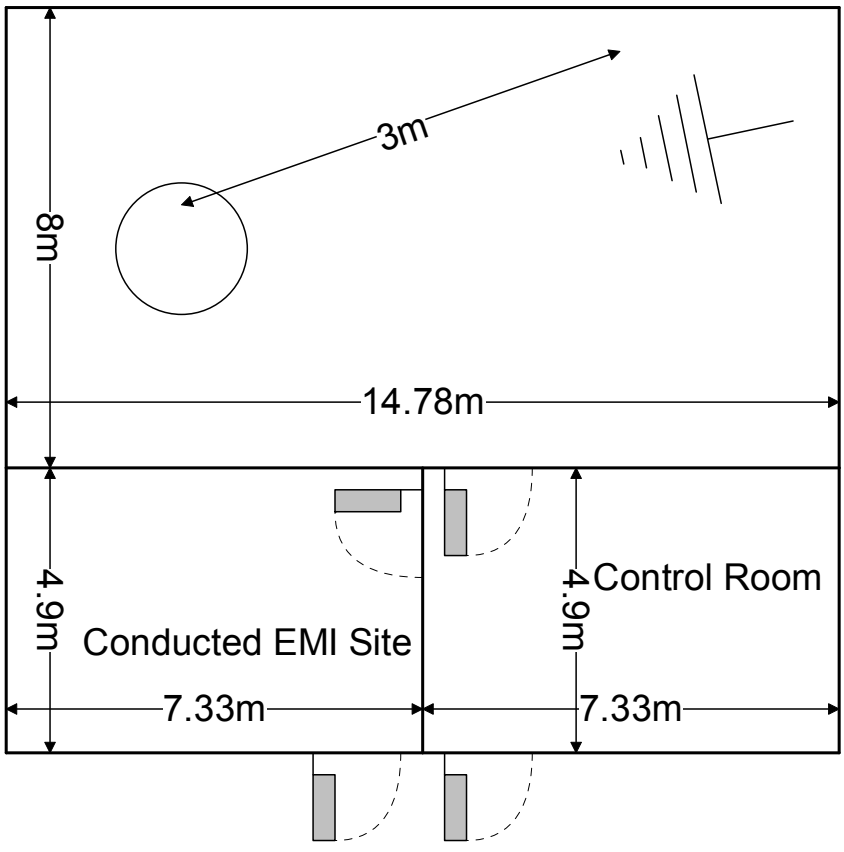

Figure 2.3.1-1: Semi-Anechoic Chamber Test Site

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:

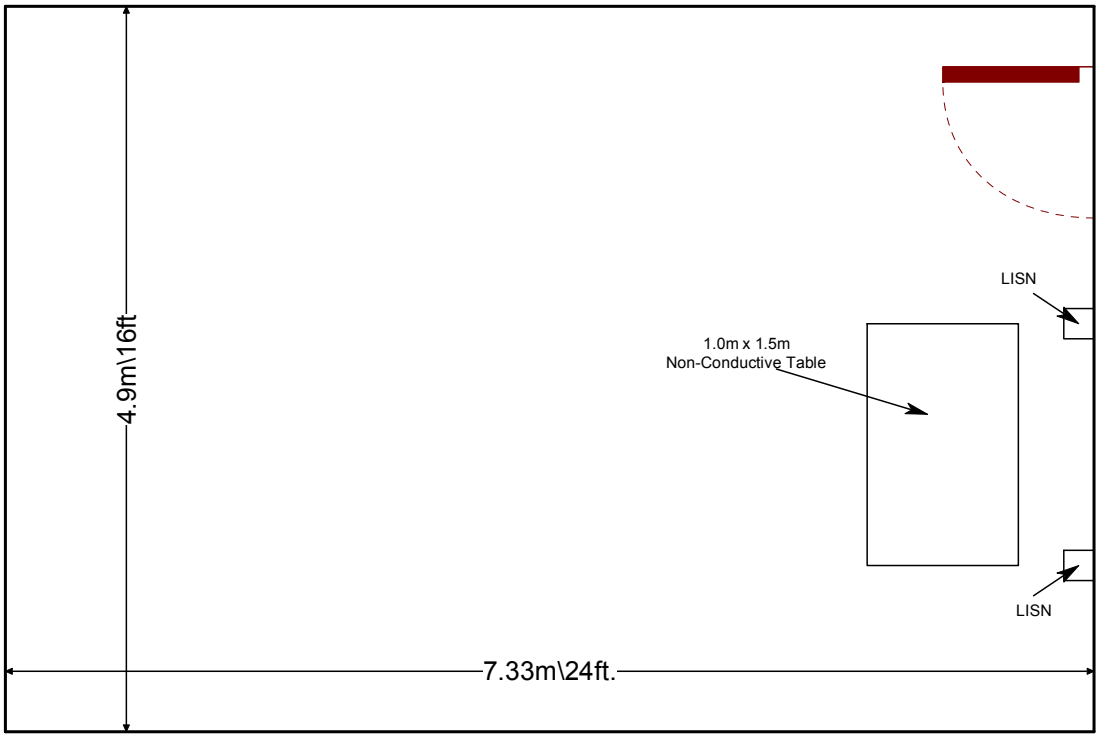

Figure 2.3.2-1: AC Mains Conducted EMI Site

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
- ANSI C63.10-2009: American National Standard for Testing Unlicensed Wireless Devices.
- US Code of Federal Regulations (CFR): Title 47, Part 2, Subpart J: Equipment Authorization Procedures, 2013
- US Code of Federal Regulations (CFR): Title 47, Part 15, Subpart C: Radio Frequency Devices, Intentional Radiators, 2013
- KDB Publication No. 558074 D01 Meas Guidance v03r01 – Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under 15.247, April 9, 2013.
- 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	1/8/2013	1/8/2015
524	Chase	CBL6111	Antennas	1138	1/7/2013	1/7/2015
2006	EMCO	3115	Antennas	2573	4/24/2013	4/24/2015
2008	COM-Power	AH-826	Antennas	81009	NCR	NCR
2011	Hewlett-Packard	HP 8447D	Amplifiers	2443A03952	12/31/2012	12/31/2013
2022	EMCO	LISN3825/2R	LISN	1095	8/19/2011	8/19/2013
2037	ACS Boca	Chamber EMI Cable Set	Cable Set	2037	1/1/2013	1/1/2014
2044	QMI	N/A	Cables	2044	12/31/2012	12/31/2013
2045	ACS Boca	Conducted Cable Set	Cable Set	2045	12/31/2012	12/31/2013
2064	CIR Q-TEL	FHT/22-10K-13/50-3A/3A	Filter	9	12/31/2012	12/31/2013
2070	Mini Circuits	VHF-8400+	Filter	2070	12/31/2012	12/31/2013
2072	Mini Circuits	VHF-3100+	Filter	30737	12/31/2012	12/31/2013
2075	Hewlett Packard	8495B	Attenuators	2626A11012	12/31/2012	12/31/2013
2076	Hewlett Packard	HP5061-5458	Cables	2076	12/29/2012	12/29/2013
2082	Teledyne Storm Products	90-010-048	Cables	2082	5/31/2013	5/31/2014
2086	Merrimac	FAN-6-10K	Attenuators	23148-83-1	12/29/2012	12/29/2013
2089	Agilent Technologies, Inc.	83017A	Amplifiers	3123A00214	12/20/2012	12/20/2013
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

NCR=No Calibration Required

5 SUPPORT EQUIPMENT

Table 5-1: EUT and Support Equipment (RF200APD1)

Item #	Type Device	Manufacturer	Model/Part #	Serial #
1	EUT	Synapse Wireless, Inc.	RF200A	536B69
2	Evaluation Board	Synapse Wireless, Inc	500202.01A	N/A
3	9 V Power Supply	Tamura Corp.	318AS09035	0705
4	Dipole Antenna	Synapse Wireless, Inc	N/A	N/A

Table 5-2: EUT and Support Equipment (RF200APF1)

Item #	Type Device	Manufacturer	Model/Part #	Serial #
1	EUT	Synapse Wireless, Inc.	RF200A	536368
2	Evaluation Board	Synapse Wireless, Inc	500202.01A	N/A
3	9 V Power Supply	Tamura Corp.	318AS09035	0705

Table 5-3: Cable Description (Radiated and Power Line Conducted Setup)

Cable #	Cable Type	Length	Shield	Termination
A	Power	1.94 m	No	Evaluation Board to Power Supply
B	Extension Cord	1.77 m	No	Power Supply to AC Mains

6 EQUIPMENT UNDER TEST SETUP BLOCK DIAGRAM

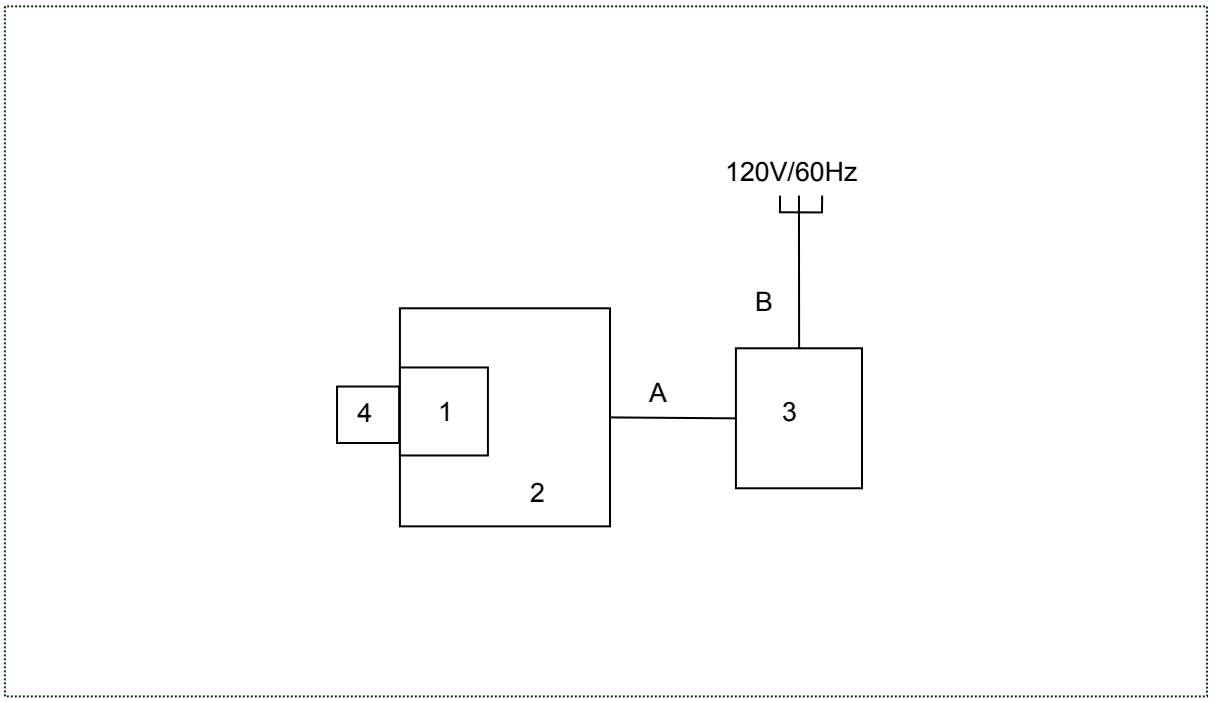

Figure 6-1: RF200APD1 Test Setup

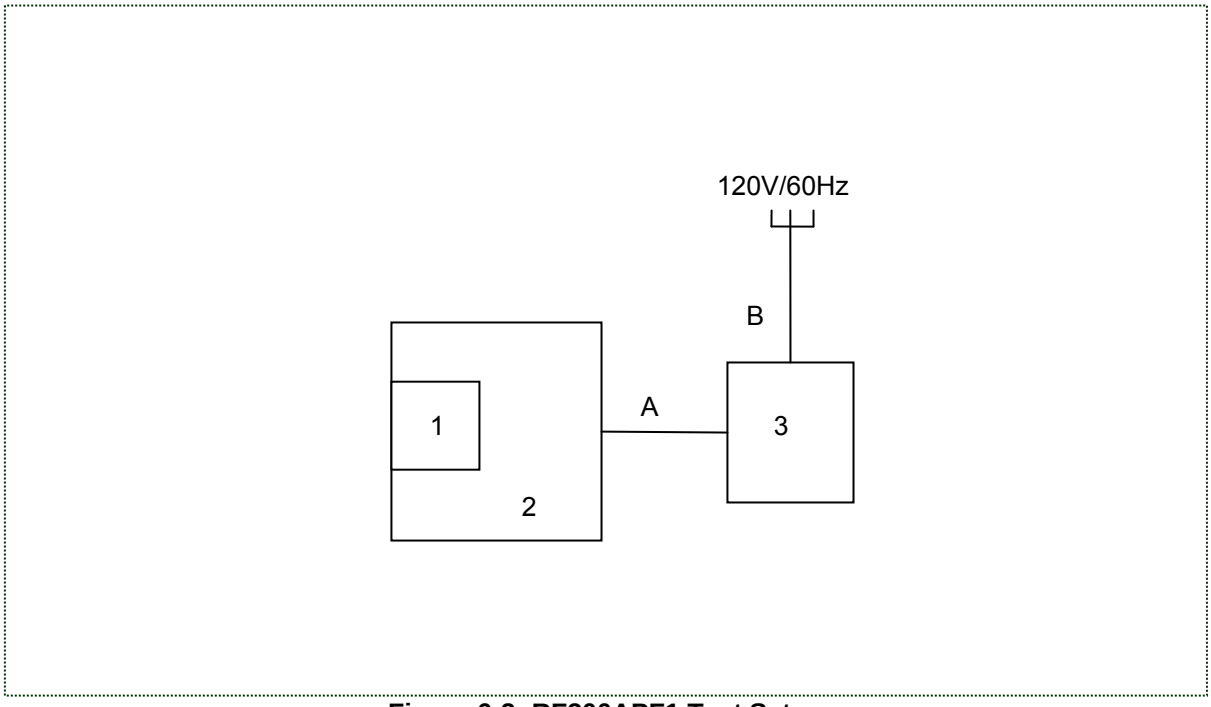

Figure 6-2: RF200APF1 Test Setup

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: Section 15.203

The RF200A comes in two configurations. One configuration uses a RSMA connector at the antenna port for connection with a RSMA dipole antenna (RF200APD1). The other configuration includes an integral PCB inverted-F antenna (RF200APF1). The RF200A meets the requirements of FCC Section 15.203 for both antenna configurations.

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)” Option 1. The RBW of the spectrum analyzer was set to 100 kHz and VBW 300 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	960	2350
2440	960	2370
2475	960	2460
2480	920	2470

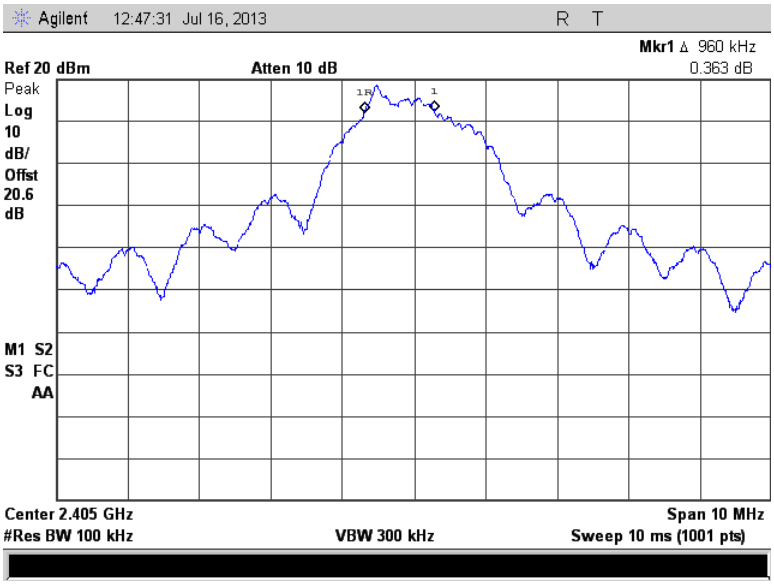

Figure 7.2.2-1: 6dB BW – 2405 MHz

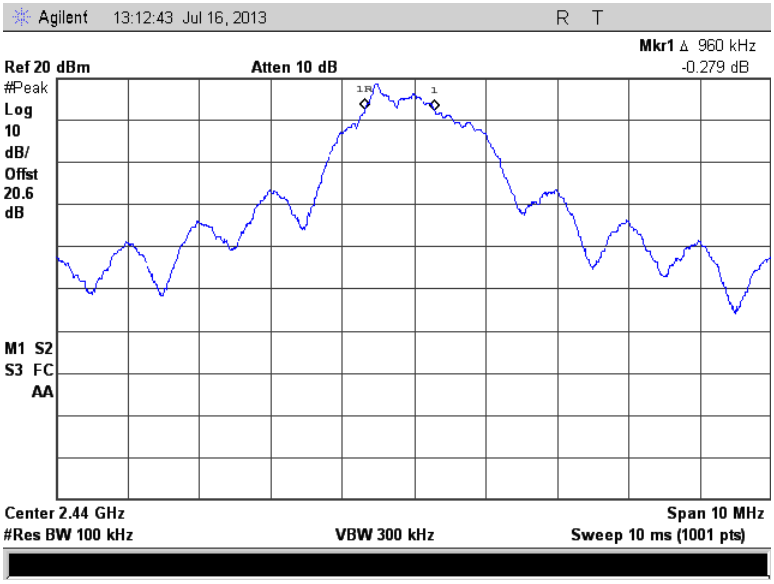

Figure 7.2.2-2: 6dB BW – 2440 MHz

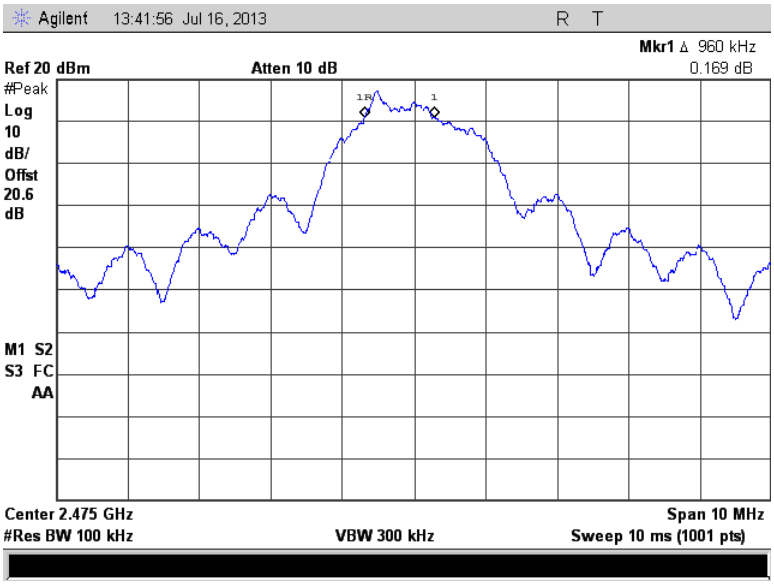

Figure 7.2.2-3: 6dB BW – 2475 MHz

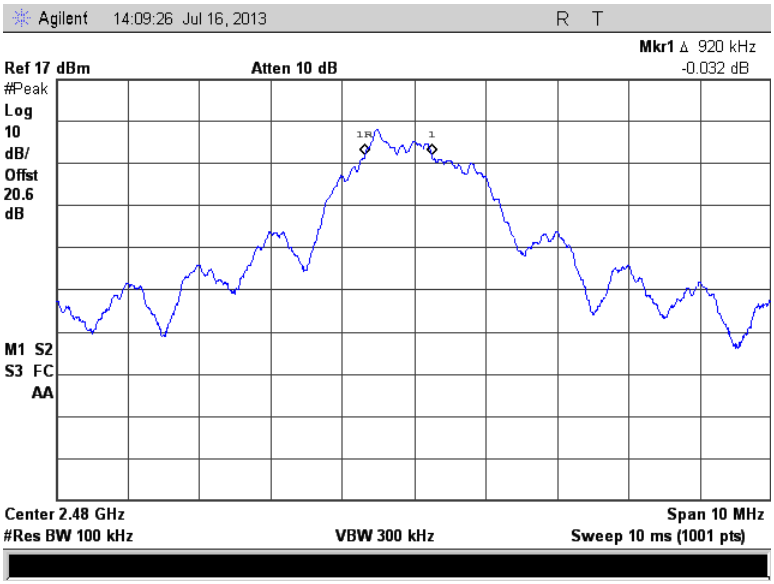

Figure 7.2.2-4: 6dB BW – 2480 MHz

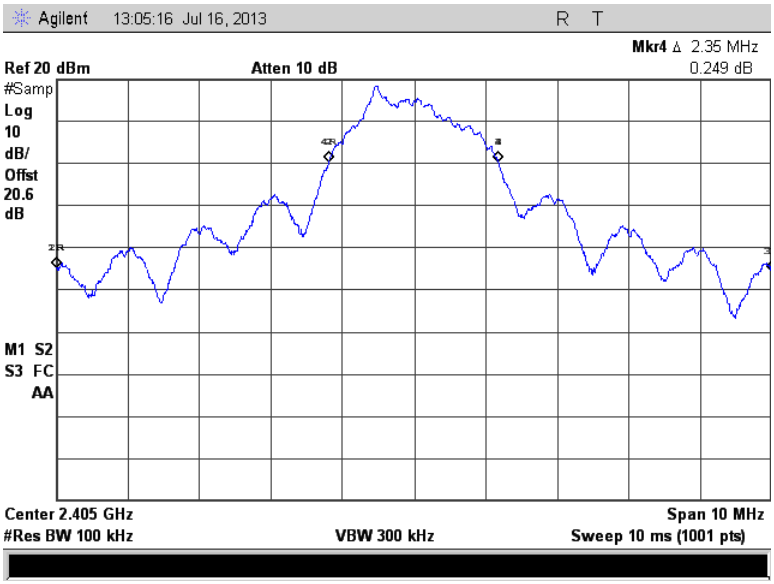

Figure 7.2.2-5: 99% OBW – 2405 MHz

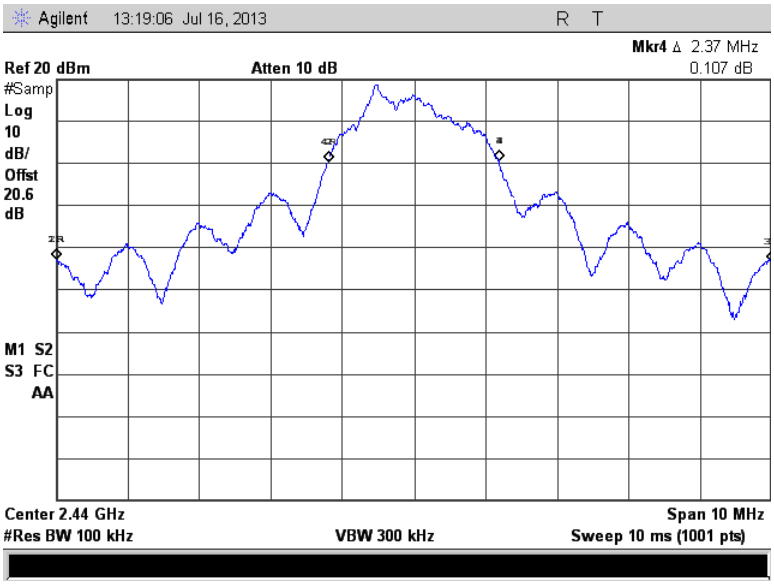

Figure 7.2.2-6: 99% OBW – 2440 MHz

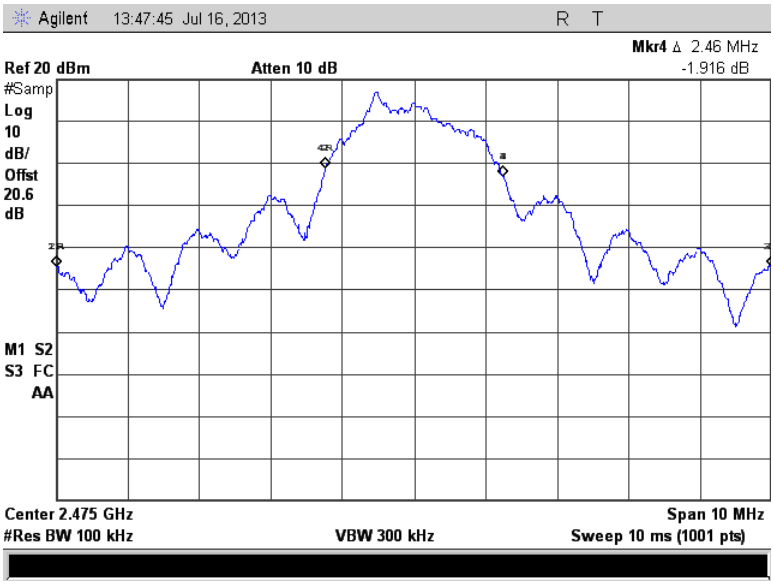

Figure 7.2.2-7: 99% OBW – 2475 MHz

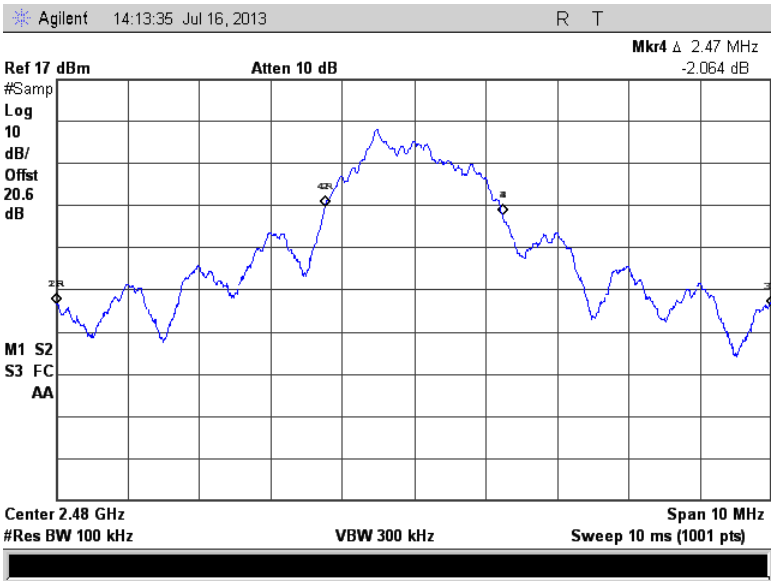

Figure 7.2.2-8: 99% OBW – 2480 MHz

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)" Section 9.1.1 RBW DTS ≥ BW. 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	18.50
2440	18.76
2475	17.19
2480	5.084

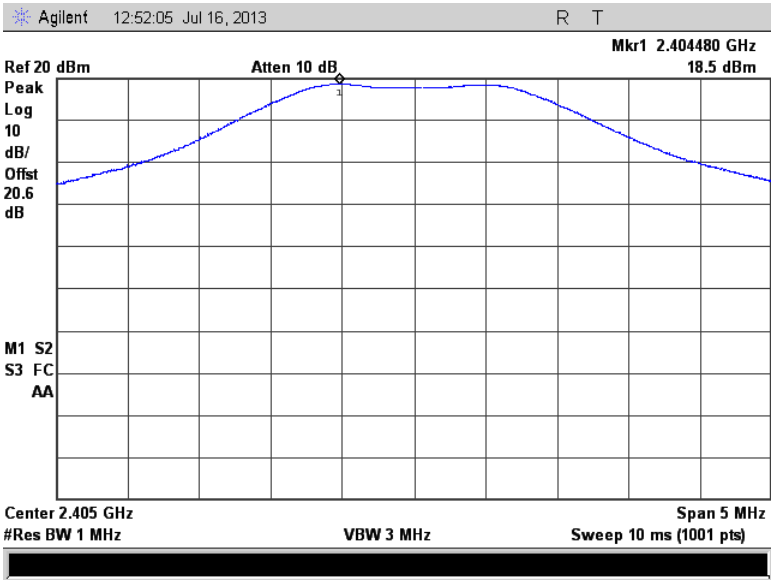

Figure 7.3.2-1: RF Output Power – 2405 MHz

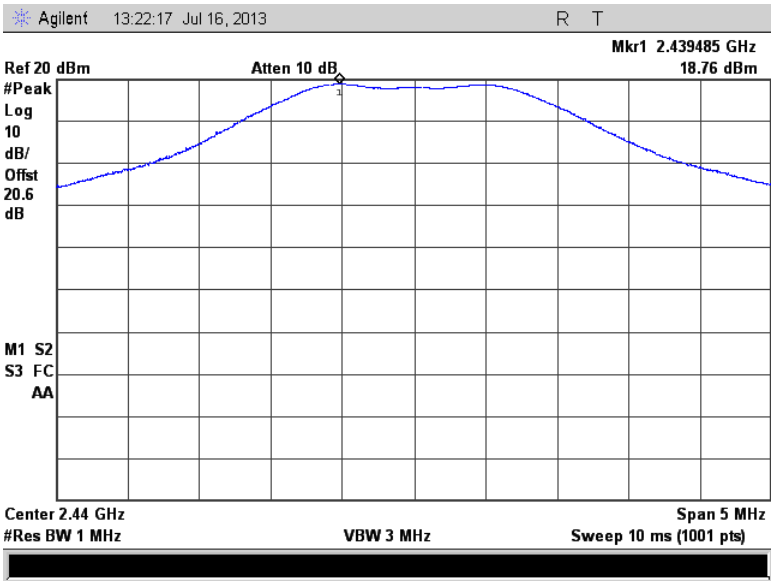

Figure 7.3.2-2: RF Output Power – 2440 MHz

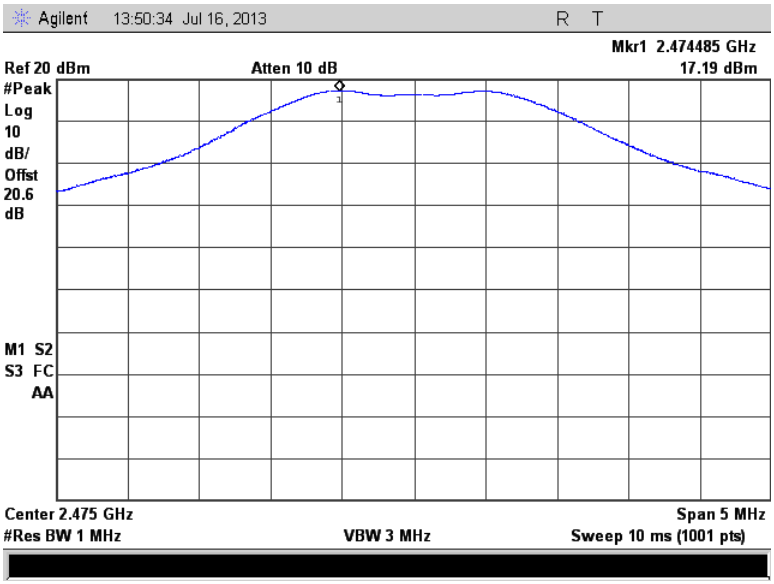

Figure 7.3.2-3: RF Output Power – 2475 MHz

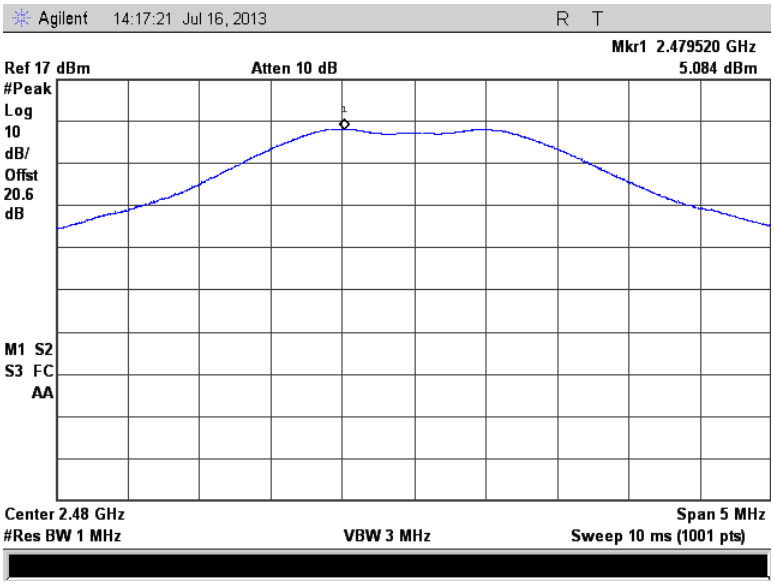

Figure 7.3.2-4: RF Output Power – 2480 MHz

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. The reference level was determined by measuring the PSD level in any 100 kHz bandwidth within the DTS channel bandwidth.

The measurements were collected at the low channel, the next to the last channel and the high channel.

7.4.1.2 Measurement Results

Results are shown below.

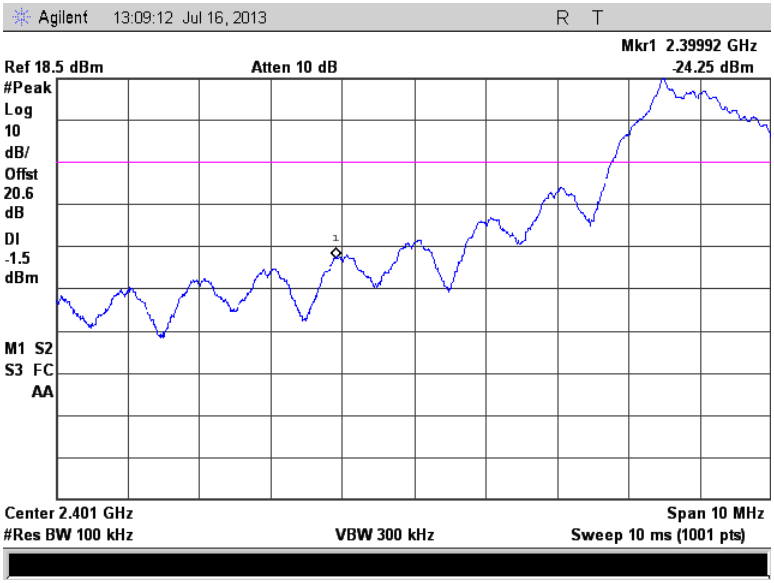

Figure 7.4.1.2-1: Band-edge - 2405 MHz

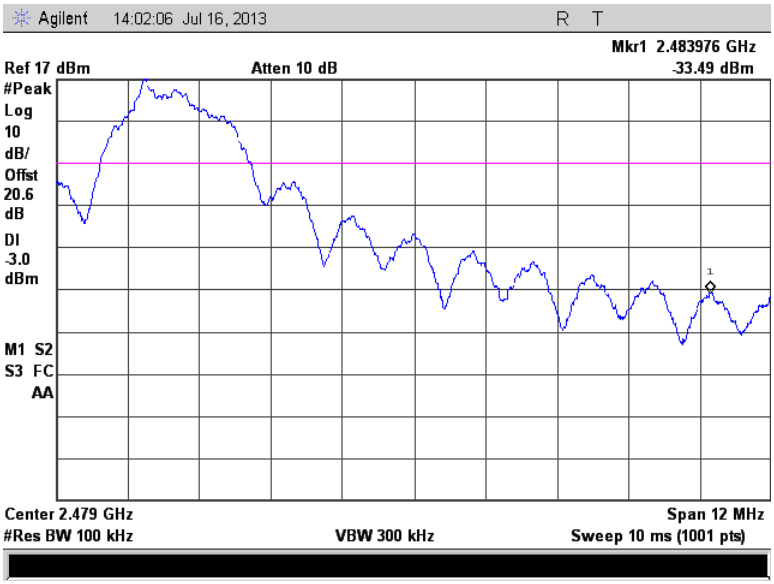

Figure 7.4.1.2-2: Band-edge - 2475 MHz

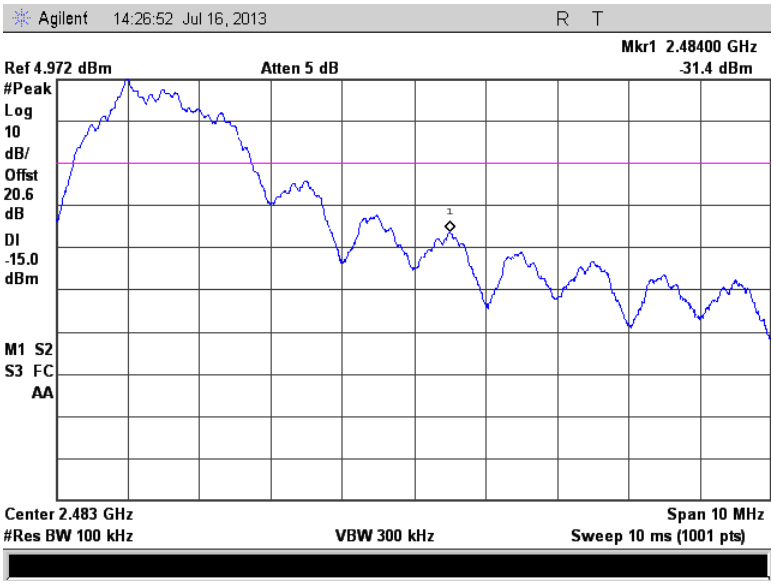

Figure 7.4.1.2-3: Band-edge - 2480 MHz

7.4.2 Band-Edge Compliance of Radiated Spurious Emissions (Marker-Delta Method)

7.4.2.1 Measurement Procedure

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

A duty cycle correction factor of 14.1% ≈ -17.02 dB was applied to the average measurements. The justification for the correction is documented in the customer's theory of operation.

7.4.2.2 Measurement Results

Results are shown below.

RF200APD1 (Dipole Antenna)

Table 7.4.2.2-1: Radiated Band-Edge - 2480 MHz

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	100.20	96.81	H	-8.28	91.92	71.52	36.11	55.81	35.41	18.19	18.59
2480	114.10	110.90	V	-8.28	105.82	85.61	37.11	68.71	48.50	5.29	5.50

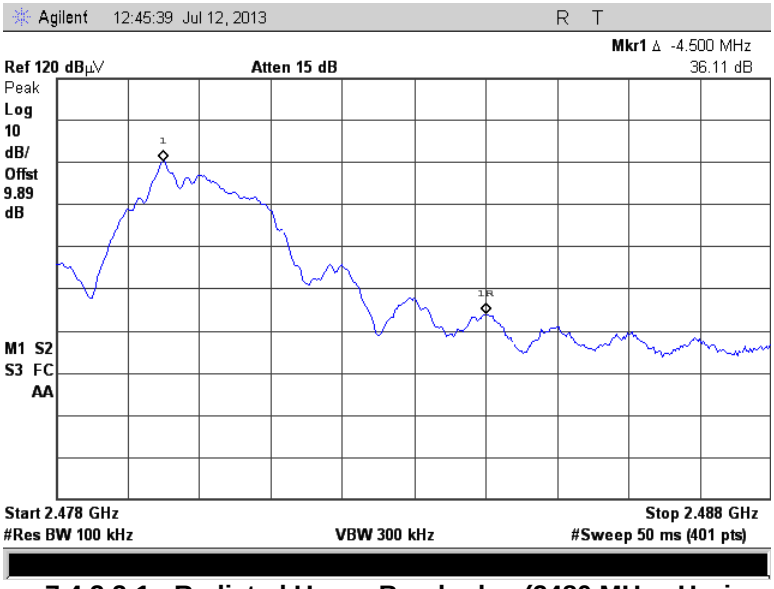

Figure 7.4.2.2-1: Radiated Upper Band-edge (2480 MHz - Horizontal)

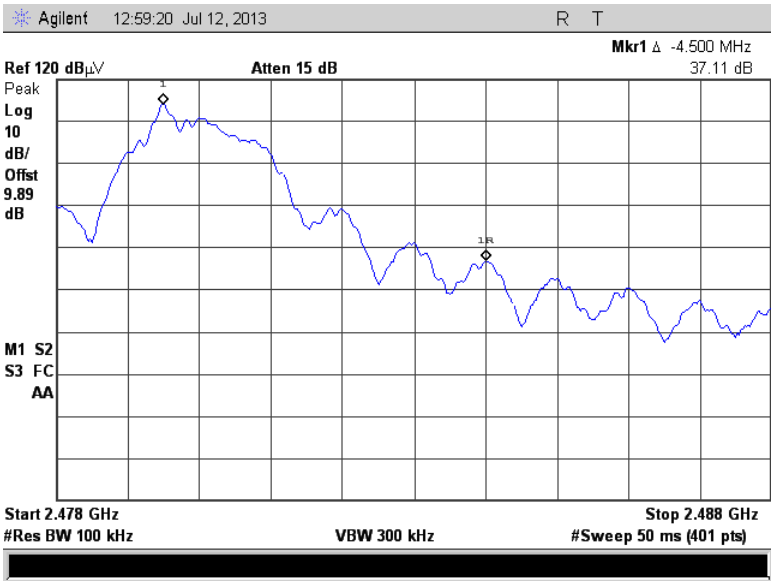

Figure 7.4.2.2-2: Radiated Upper Band-edge (2480 MHz - Vertical)

RF200APF1 (PCB Inverted-F Antenna)

Table 7.4.2.2-2: Radiated Band Edge - 2480 MHz

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	110.90	108.40	H	-8.28	102.62	83.11	36.27	66.35	46.84	7.65	7.16
2480	109.00	106.40	V	-8.28	100.72	81.11	36.16	64.56	44.95	9.44	9.05

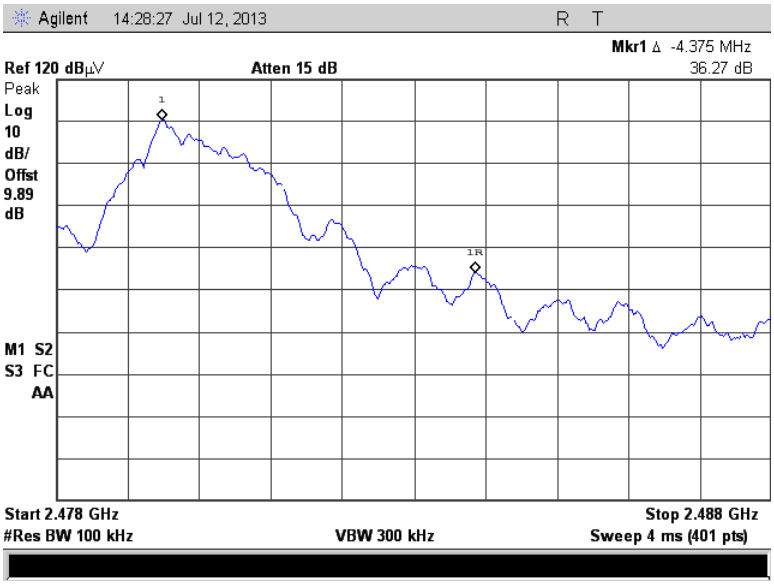

Figure 7.4.2.2-3: Radiated Upper Band-edge (2480 MHz - Horizontal)

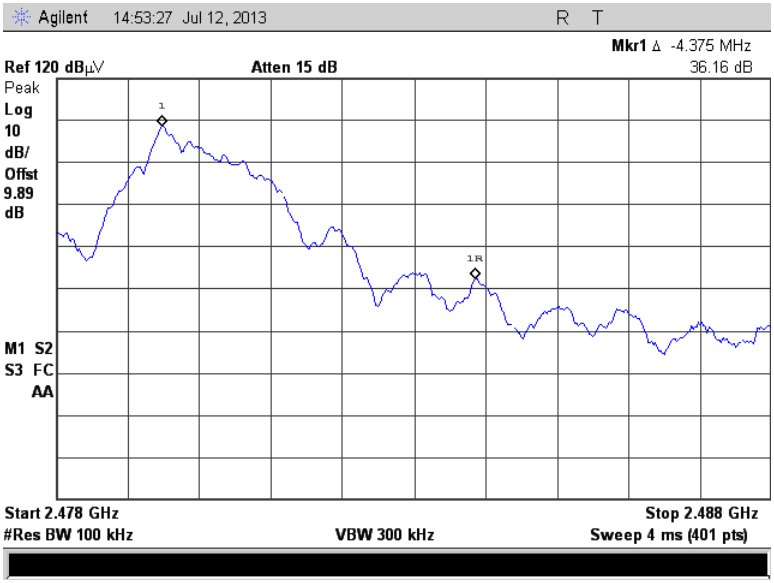

Figure 7.4.2.2-4: Radiated Upper Band-edge (2480 MHz - Vertical)

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 reference level was determined by measuring the PSD level in any 100 kHz bandwidth within the DTS channel bandwidth. The RF output port of the equipment under test was directly connected to the input of the spectrum analyzer. The Resolution Bandwidth (RBW) of the spectrum analyzer was set to 100 kHz. The Video Bandwidth (VBW) was set to ≥ 300 kHz. Span was set to 1.5 times the DTS bandwidth. The trace was set to max hold with a peak detector active. The resulting spectrum analyzer peak level was used to determine the reference level with respect to the 20 dBc limit.

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.

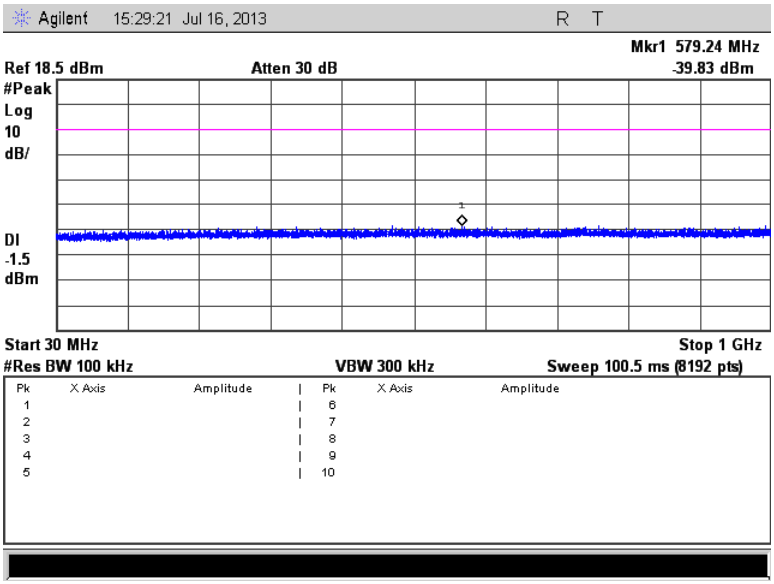

Figure 7.4.3.2-1: 30 MHz – 1 GHz – 2405 MHz

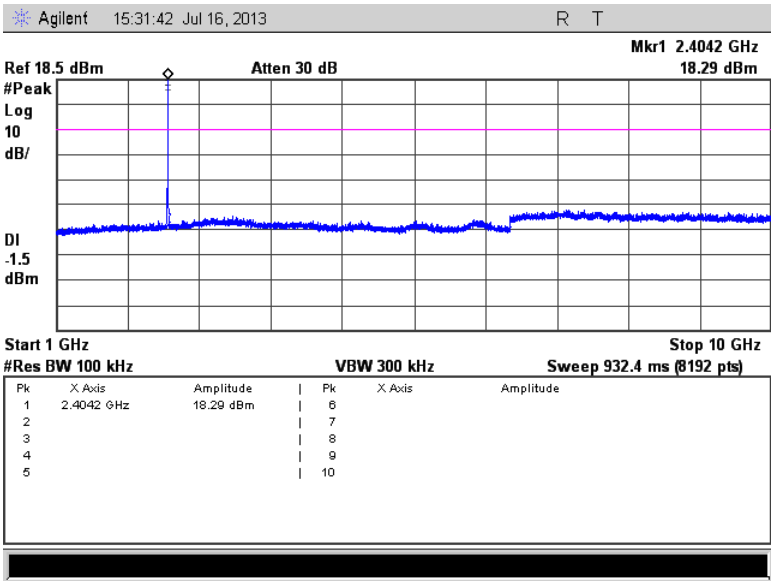

Figure 7.4.3.2-2: 1 GHz – 10 GHz – 2405 MHz

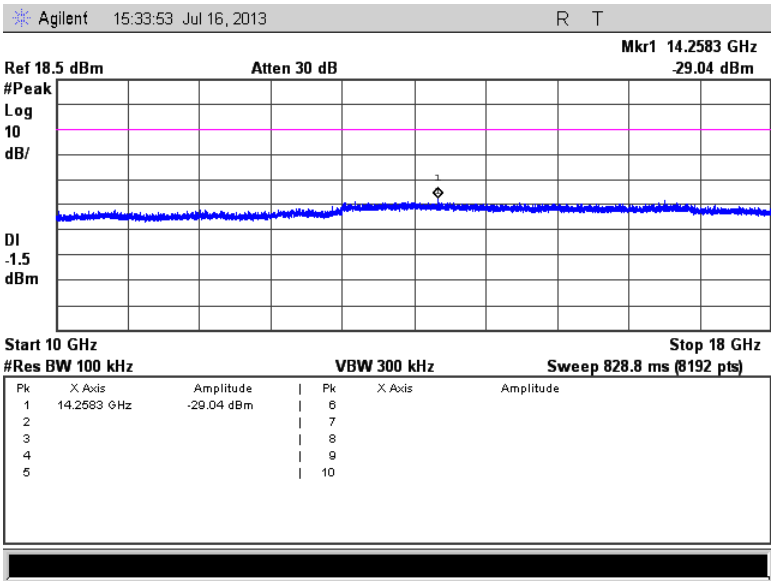

Figure 7.4.3.2-3: 10 GHz – 18 GHz – 2405 MHz

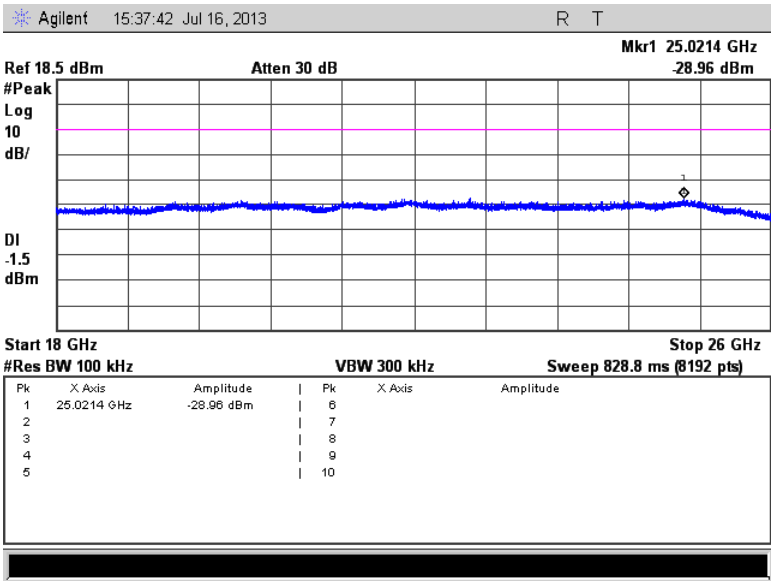

Figure 7.4.3.2-4: 18 GHz – 26 GHz – 2405 MHz

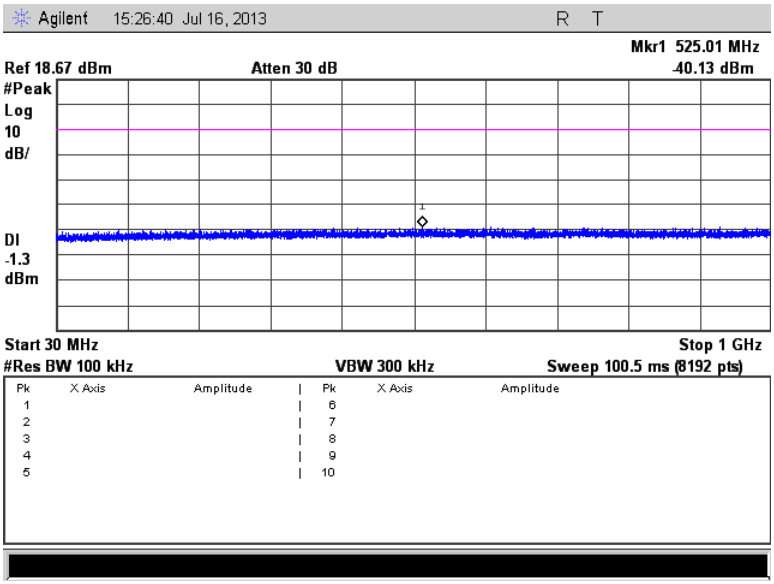

Figure 7.4.3.2-5: 30 MHz – 1 GHz – 2440 MHz

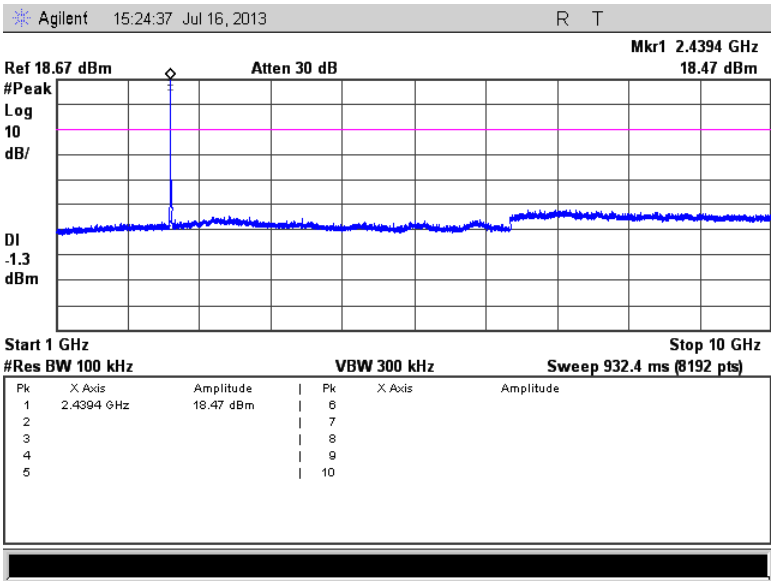

Figure 7.4.3.2-6: 1 GHz – 10 GHz – 2440 MHz

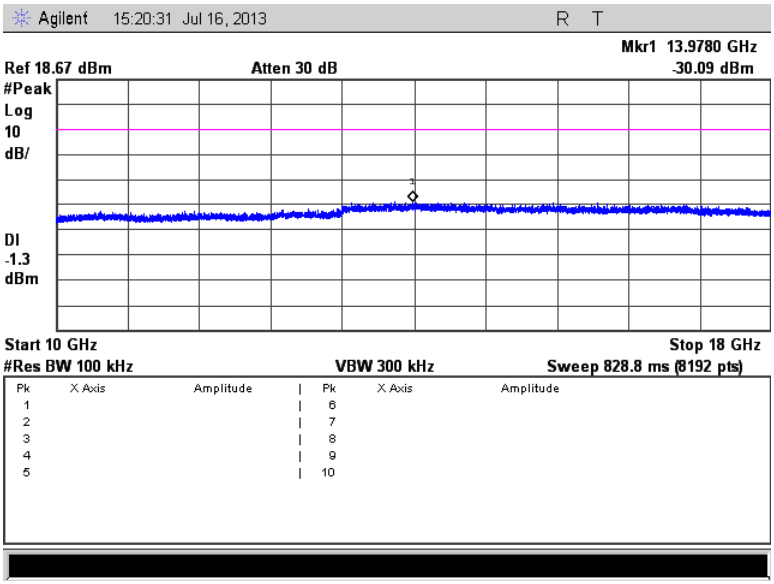

Figure 7.4.3.2-7: 10 GHz – 18 GHz – 2440 MHz

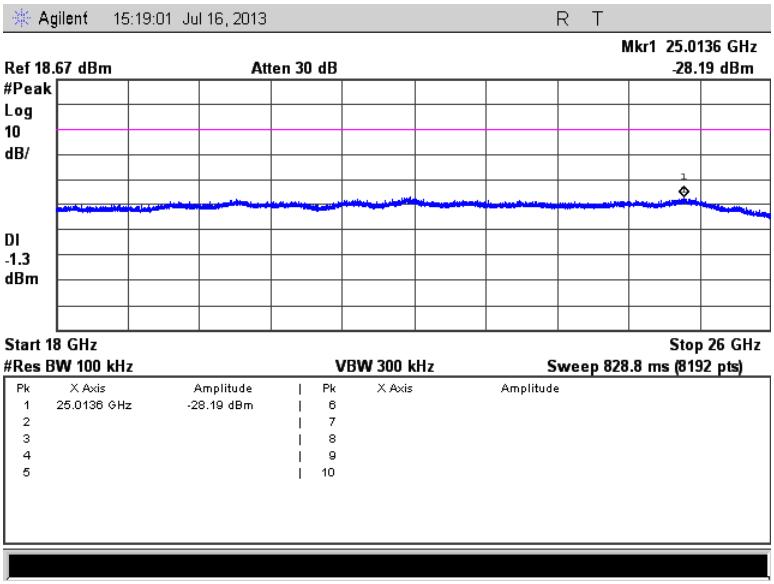

Figure 7.4.3.2-8: 18 GHz – 26 GHz – 2440 MHz

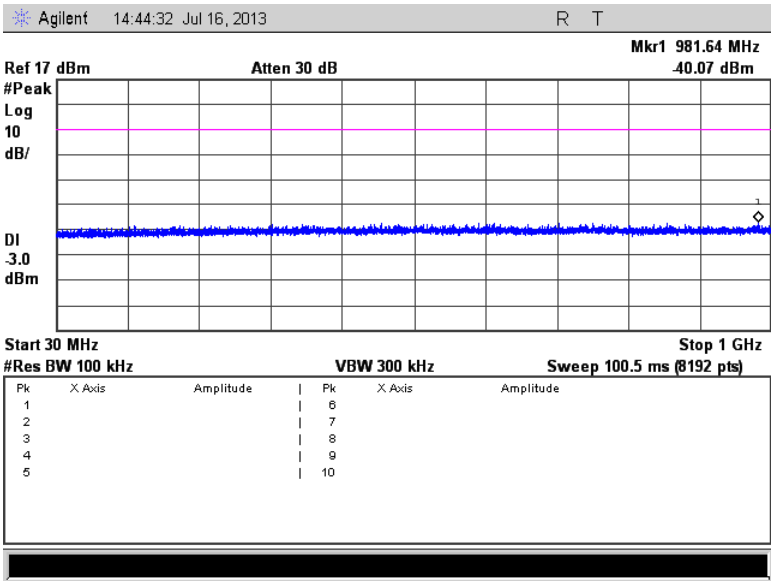

Figure 7.4.3.2-9: 30 MHz – 1 GHz – 2475 MHz

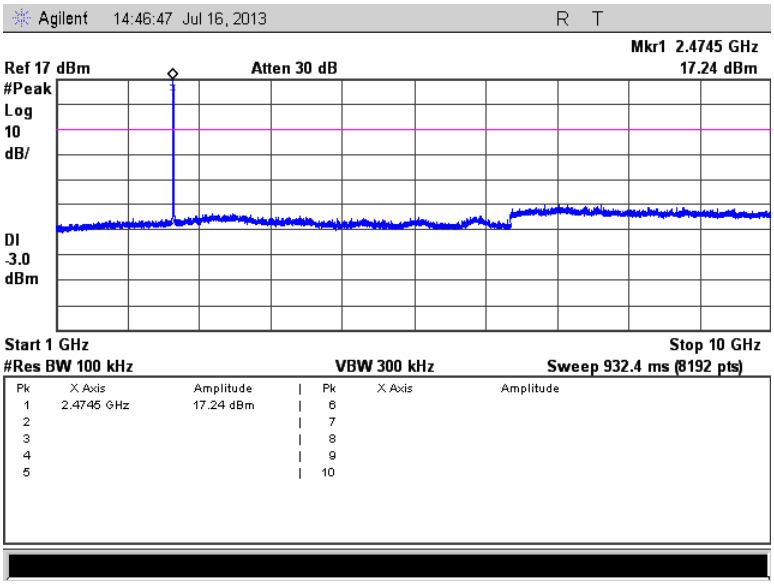

Figure 7.3.2.2-10: 1 GHz – 10 GHz – 2475 MHz

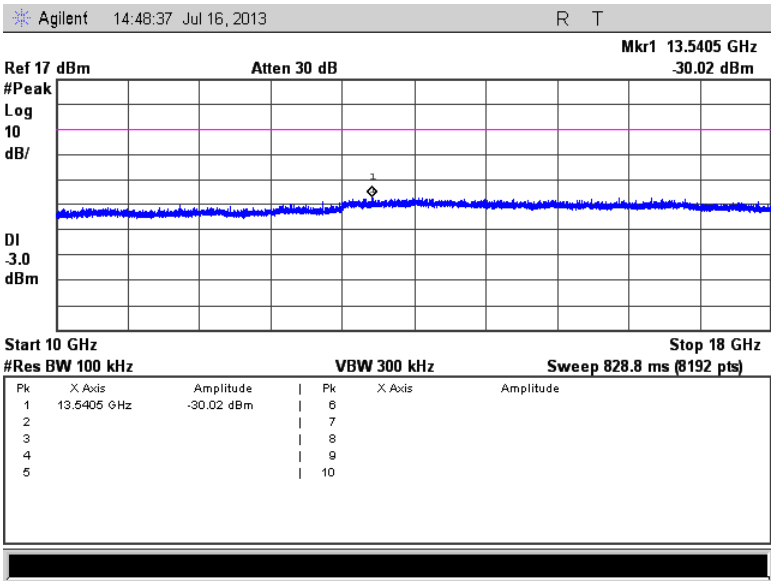

Figure 7.4.3.2-11: 10 GHz – 18 GHz – 2475 MHz

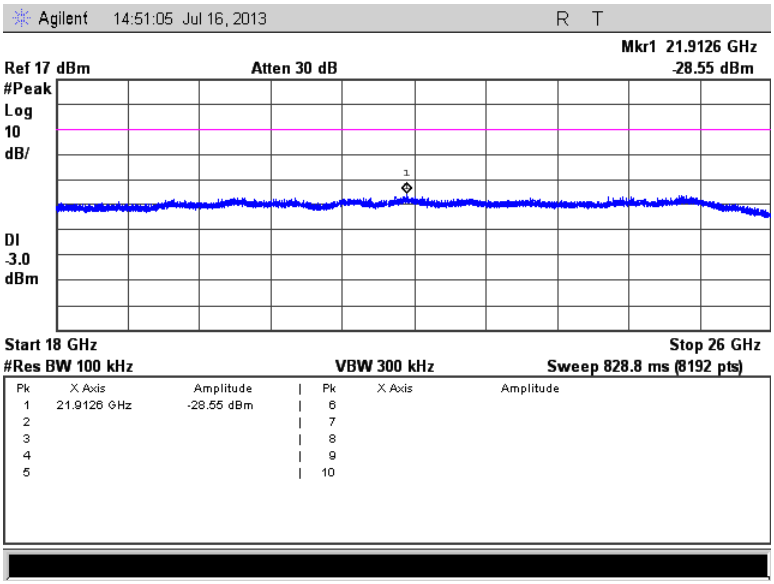

Figure 7.4.3.2-12: 18 GHz – 26 GHz – 2475 MHz

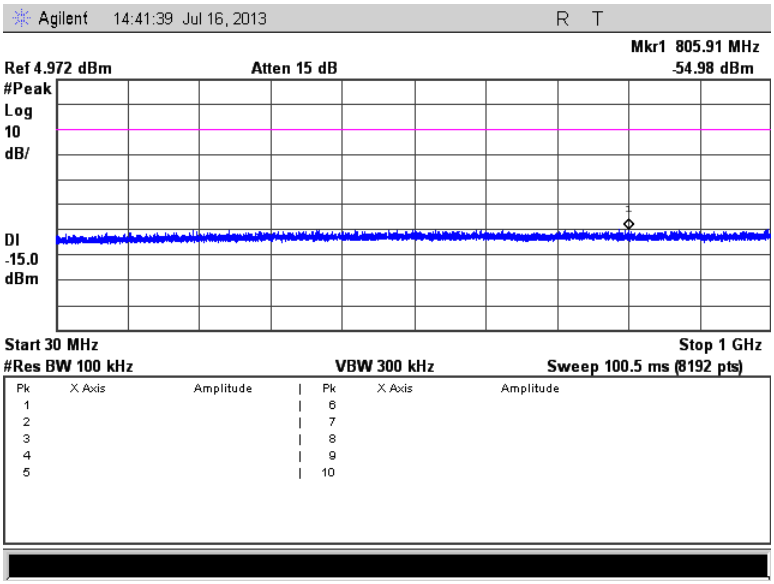

Figure 7.4.3.2-13: 30 MHz – 1 GHz – 2480 MHz

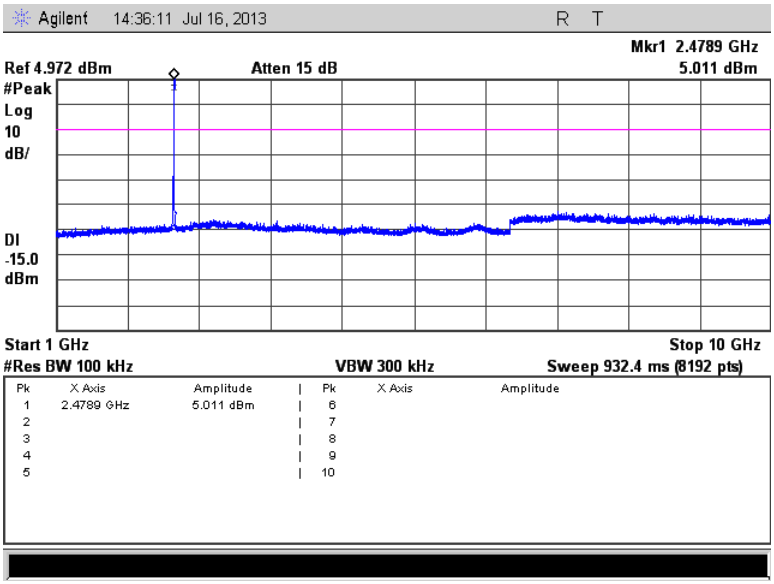

Figure 7.4.3.2-14: 1 GHz – 10 GHz – 2480 MHz

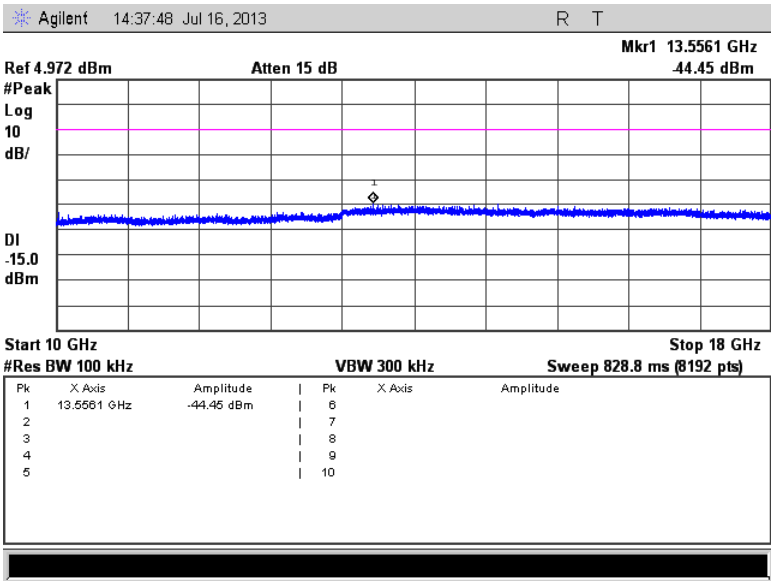

Figure 7.4.3.2-15: 10 GHz – 18 GHz – 2480 MHz

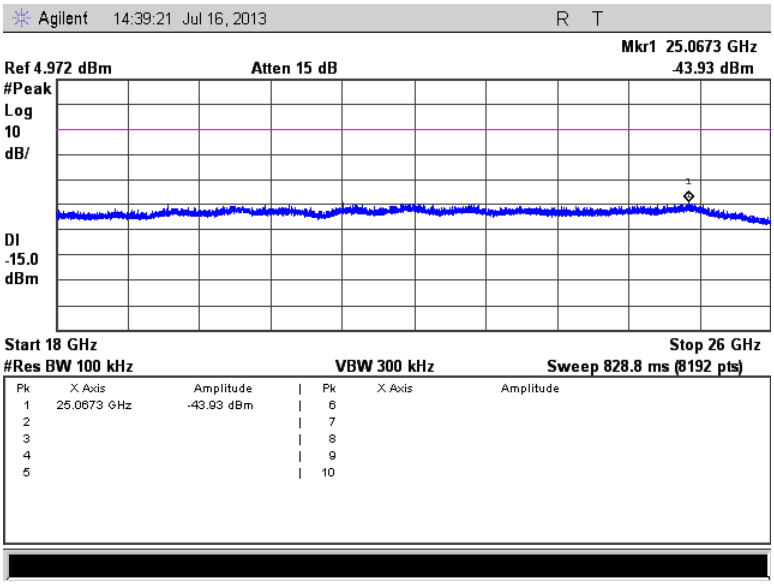

Figure 7.4.3.2-16: 18 GHz – 26 GHz – 2480 MHz

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 14.1% ≈ -17.02 dB was applied to the average measurements. 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.

RF200APD1 (Dipole Antenna)

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										
2390	61.39	51.06	H	-8.65	52.74	25.40	74.0	54.0	21.3	28.6
2390	70.42	68.59	V	-8.65	61.77	42.93	74.0	54.0	12.2	11.1
4810	56.23	50.25	H	-0.87	55.36	32.37	74.0	54.0	18.6	21.6
4810	52.16	45.18	V	-0.87	51.29	27.30	74.0	54.0	22.7	26.7
12025	56.22	49.86	H	11.34	67.56	44.18	83.5	63.5	15.9	19.3
12025	56.18	49.81	V	11.34	67.52	44.13	83.5	63.5	16.0	19.4
19240	47.66	39.08	H	9.25	56.91	31.31	83.5	63.5	26.6	32.2
19240	49.99	42.08	V	9.25	59.24	34.31	83.5	63.5	24.3	29.2
Middle Channel = 2440 MHz										
4880	55.71	49.43	H	-0.66	55.05	31.75	74.0	54.0	19.0	22.2
4880	53.33	46.35	V	-0.66	52.67	28.67	74.0	54.0	21.3	25.3
7320	68.89	63.78	H	3.99	72.88	50.76	74.0	54.0	1.1	3.2
7320	67.87	62.87	V	3.99	71.86	49.85	74.0	54.0	2.1	4.2
12200	54.78	48.24	H	11.23	66.01	42.45	83.5	63.5	17.5	21.0
12200	53.25	45.95	V	11.23	64.48	40.16	83.5	63.5	19.0	23.3
19520	46.56	37.70	H	9.51	56.07	30.20	83.5	63.5	27.4	33.3
19520	46.97	38.38	V	9.51	56.48	30.88	83.5	63.5	27.0	32.6
High Channel = 2475 MHz										
2483.5	68.26	57.18	H	-8.26	60.00	31.90	74.0	54.0	14.0	22.1
2483.5	81.35	70.46	V	-8.26	73.09	45.18	74.0	54.0	0.9	8.8
4950	56.58	50.96	H	-0.46	56.12	33.49	74.0	54.0	17.9	20.5
4950	52.17	45.15	V	-0.46	51.71	27.68	74.0	54.0	22.3	26.3
7425	57.59	51.37	H	4.27	61.86	38.63	74.0	54.0	12.1	15.4
7425	56.81	50.26	V	4.27	61.08	37.52	74.0	54.0	12.9	16.5
12375	45.31	33.54	H	11.11	56.42	27.64	83.5	63.5	27.1	35.9
12375	45.54	33.59	V	11.11	56.65	27.69	83.5	63.5	26.8	35.8
High Channel = 2480 MHz										
4960	49.23	40.75	H	-0.43	48.80	23.31	74.0	54.0	25.2	30.7
4960	48.49	37.68	V	-0.43	48.06	20.24	74.0	54.0	25.9	33.8

Notes:

- All emissions above 19520 MHz were attenuated below the limits and the noise floor of the measurement equipment.
- The average measurements are further corrected using a duty cycle of 14.1%. The justification for the duty cycle is documented in the Theory of Operations of the product.
- The measurements above 10 GHz were collected at a distance of 1m. The limits are corrected accordingly using a distance factor of 20*log(3/1) ≈ 9.5 dB.

RF200APF1 (PCB Inverted-F Antenna)

Table 7.4.4.2-2: Radiated Spurious Emissions Tabulated Data

Frequency (MHz)	Level (dBuV)		Antenna Polarity (H/V)	Correction Factors (dB)	Corrected Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
	pk	Qpk/Avg			pk	Qpk/Avg	pk	Qpk/Avg	pk	Qpk/Avg
Low Channel = 2405 MHz										
2390	71.79	60.55	H	-8.65	63.14	34.89	74.0	54.0	10.9	19.1
2390	69.59	58.72	V	-8.65	60.94	33.06	74.0	54.0	13.1	20.9
4810	64.82	60.02	H	-0.87	63.95	42.14	74.0	54.0	10.0	11.9
4810	61.55	56.37	V	-0.87	60.68	38.49	74.0	54.0	13.3	15.5
12025	50.46	43.23	H	11.34	61.80	37.55	83.5	63.5	21.7	25.9
12025	47.80	36.71	V	11.34	59.14	31.03	83.5	63.5	24.4	32.5
19240	45.23	35.80	H	9.25	54.48	28.03	83.5	63.5	29.0	35.5
19240	45.57	36.99	V	9.25	54.82	29.22	83.5	63.5	28.7	34.3
Middle Channel = 2440 MHz										
4880	65.07	61.96	H	-0.66	64.41	44.28	74.0	54.0	9.6	9.7
4880	63.86	60.72	V	-0.66	63.20	43.04	74.0	54.0	10.8	11.0
7320	67.30	63.74	H	3.99	71.29	50.72	74.0	54.0	2.7	3.3
7320	65.26	61.49	V	3.99	69.25	48.47	74.0	54.0	4.7	5.5
12200	50.47	43.42	H	11.23	61.70	37.63	83.5	63.5	21.8	25.9
12200	46.09	35.52	V	11.23	57.32	29.73	83.5	63.5	26.2	33.8
19520	43.11	31.23	H	9.51	52.62	23.73	83.5	63.5	30.9	39.8
19520	43.36	31.92	V	9.51	52.87	24.42	83.5	63.5	30.6	39.1
Next to the Highest Channel = 2475 MHz										
2483.5	78.52	68.43	H	-8.26	70.26	43.15	74.0	54.0	3.7	10.8
2483.5	76.24	66.21	V	-8.26	67.98	40.93	74.0	54.0	6.0	13.1
4950	61.67	56.58	H	-0.46	61.21	39.11	74.0	54.0	12.8	14.9
4950	63.20	58.18	V	-0.46	62.74	40.71	74.0	54.0	11.3	13.3
7425	53.25	44.39	H	4.27	57.52	31.65	74.0	54.0	16.5	22.4
7425	52.52	43.92	V	4.27	56.79	31.18	74.0	54.0	17.2	22.8
12375	46.17	35.09	H	11.11	57.28	29.19	83.5	63.5	26.2	34.3
12375	44.92	32.80	V	11.11	56.03	26.90	83.5	63.5	27.5	36.6
High Channel = 2480 MHz										
4960	50.89	42.04	H	-0.43	50.46	24.60	74.0	54.0	23.5	29.4
4960	51.89	43.66	V	-0.43	51.46	26.22	74.0	54.0	22.5	27.8

Notes:

- All emissions above 19520 MHz were attenuated below the limits and the noise floor of the measurement equipment.
- The average measurements are further corrected using a duty cycle of 14.1%. The justification for the duty cycle is documented in the Theory of Operations of the product.
- The measurements above 10 GHz were collected at a distance of 1m. The limits are corrected accordingly using a distance factor of 20*log(3/1) ≈ 9.5 dB.

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(14.1/100) = -17.02 dB

Example Calculation: Peak
Corrected Level: 61.39 - 8.65 = 52.74 dBµV/m
Margin: 74 dBµV/m – 52.74 dBµV/m = 21.3 dB

Example Calculation: Average
Corrected Level: 51.06 -8.65 - 17.02= 25.39 dBµV/m
Margin: 54 dBµV/m – 25.39 dBµV/m = 28.6 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 Section 10.2 Method 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 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: RF Output Power

Frequency (MHz)	PSD/3kHz (dBm)	Limit (dBm)	Margin (dB)
2405	4.786	8	3.214
2440	4.086	8	3.914
2475	3.341	8	4.659
2480	-8.071	8	16.071

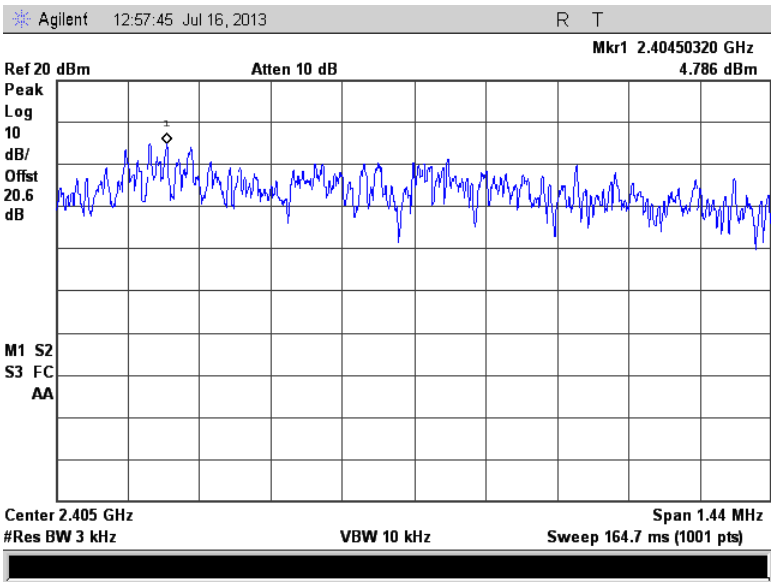

Figure 7.5.2-1: Power Spectral Density – 2405 MHz

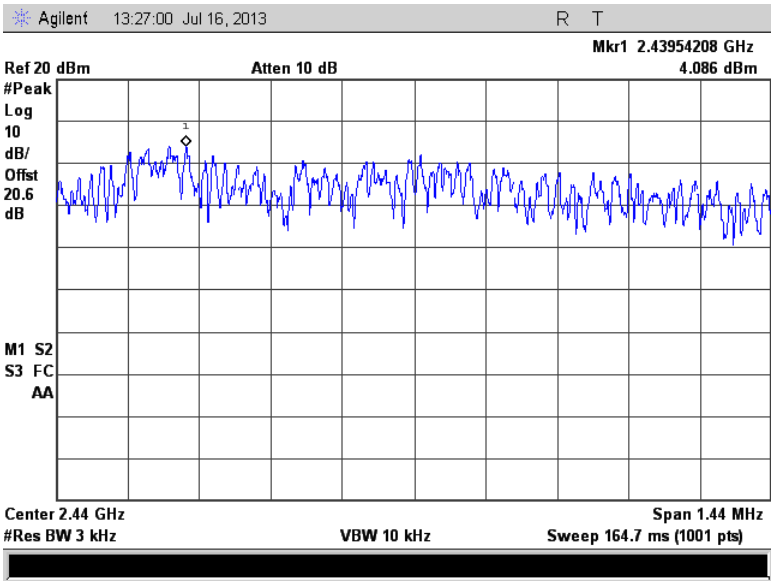

Figure 7.5.2-2: Power Spectral Density – 2440 MHz

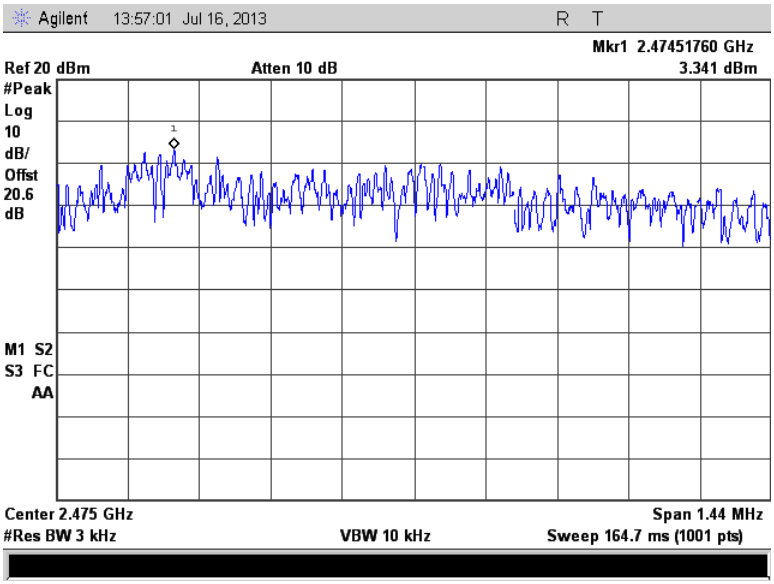

Figure 7.5.2-3: Power Spectral Density – 2475 MHz

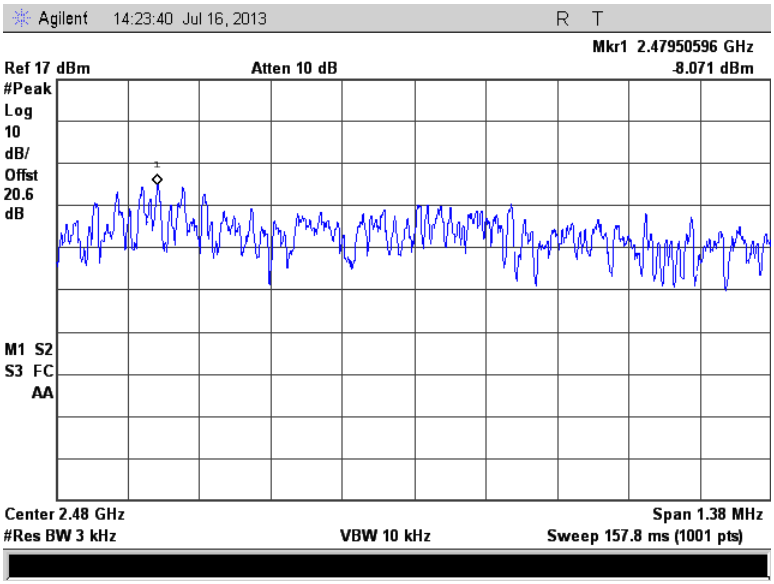

Figure 7.5.2-4: Power Spectral Density – 2480 MHz

7.6 Power Line Conducted Emissions – FCC: Section 15.207 IC: RSS-Gen 7.2.2

7.6.1 Measurement Procedure

ANSI C63.4 sections 6 and 7 were the guiding documents for this evaluation. Conducted emissions were performed from 150 kHz to 30MHz with the spectrum analyzer's resolution bandwidth set to 9 kHz and the video bandwidth set to 30 kHz. The calculation for the conducted emissions is as follows:

Corrected Reading = Analyzer Reading + LISN Loss + Cable Loss
Margin = Applicable Limit - Corrected Reading

7.6.2 Measurement Results

Results of the test are shown below.

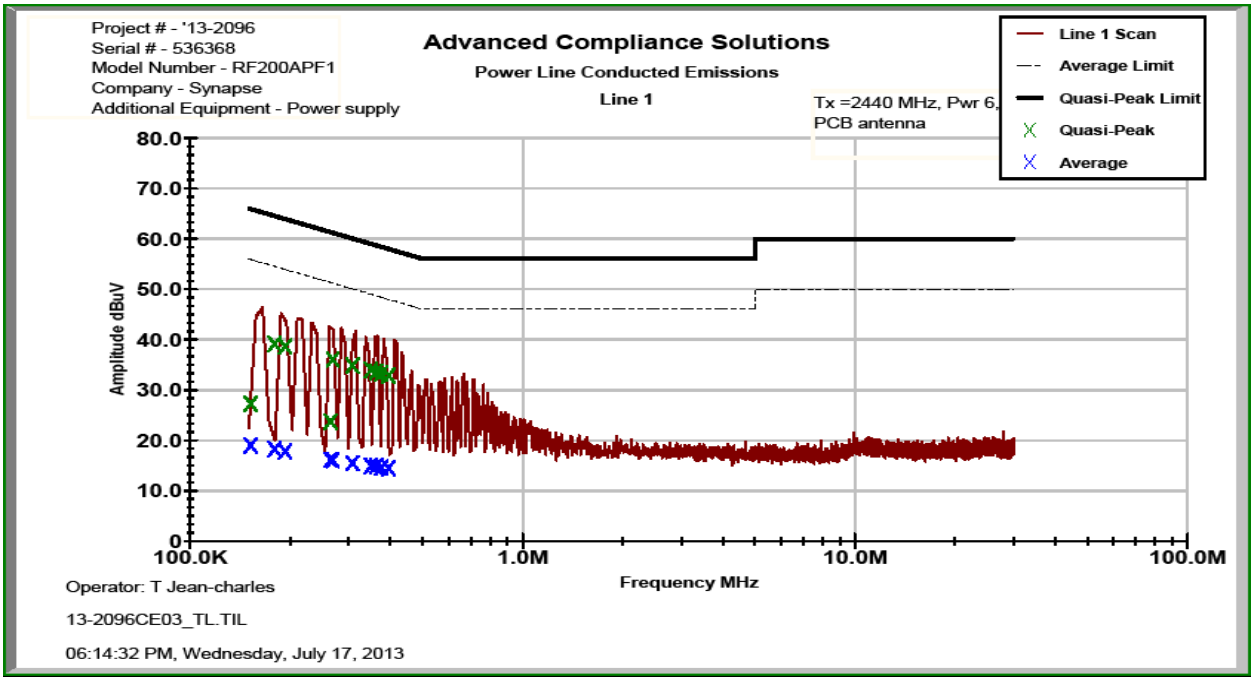

Figure 7.6.2-1: Power Line Conducted Emissions – Line 1

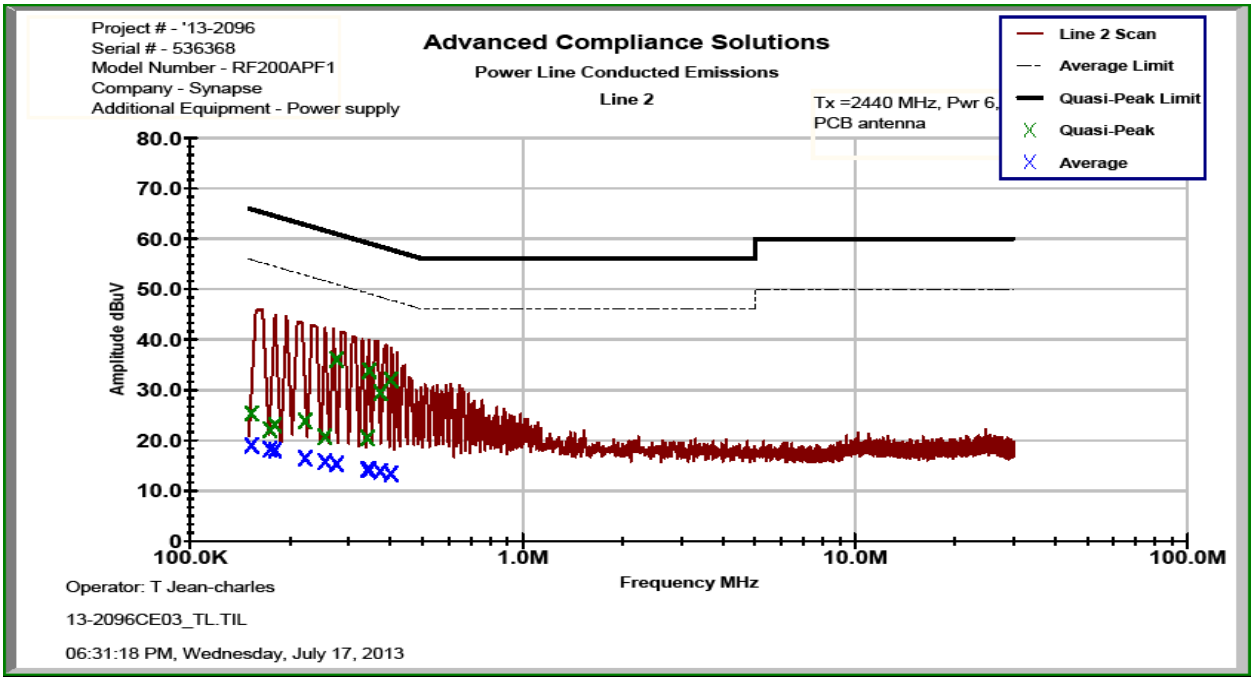

Figure 7.6.2-2: Power Line Conducted Emissions – Line 2

Table 7.6.2-1: Power Line Conducted Emissions Results

☒ Line 1 ☒ Line 2 ☐ Line 3
☐ Line 4
☐ To Ground ☒ Floating
☐ Telecom Port _____
☒ dBµV ☐ dBµA

Plot Number: 13-2096CE03
Power Supply Description: 9 VDC

Frequency (MHz)	Uncorrected Reading		Total Correction Factor (dB)	Corrected Level		Limit		Margin (dB)	
	Quasi-Peak	Average		Quasi-Peak	Average	Quasi-Peak	Average	Quasi-Peak	Average
Line 1									
0.151875	25.75	17.516	1.52	27.27	19.03	65.90	55.90	38.6	36.9
0.179063	37.89	17.012	1.31	39.20	18.32	64.53	54.53	25.3	36.2
0.192999	37.46	16.675	1.28	38.74	17.96	63.91	53.91	25.2	35.9
0.264237	22.873	15.291	0.86	23.74	16.15	61.30	51.30	37.6	35.1
0.267925	35.23	15.267	0.86	36.09	16.13	61.18	51.18	25.1	35.1
0.307225	34.084	14.705	0.74	34.82	15.44	60.05	50.05	25.2	34.6
0.349663	33.257	14.269	0.71	33.97	14.98	58.97	48.97	25.0	34.0
0.361363	32.91	14.187	0.67	33.58	14.85	58.70	48.70	25.1	33.8
0.375287	32.699	13.975	0.66	33.36	14.64	58.38	48.38	25.0	33.7
0.394587	32.253	13.877	0.65	32.91	14.53	57.97	47.97	25.1	33.4
Line 2									
0.152554	23.791	17.481	1.55	25.34	19.03	65.86	55.86	40.5	36.8
0.17365	20.784	16.879	1.35	22.13	18.23	64.78	54.78	42.7	36.6
0.179424	21.78	16.752	1.34	23.12	18.09	64.51	54.51	41.4	36.4
0.221538	22.812	15.419	1.09	23.90	16.51	62.76	52.76	38.9	36.3
0.254	19.8	14.853	0.89	20.69	15.74	61.63	51.63	40.9	35.9
0.275424	35.194	14.449	0.87	36.07	15.32	60.95	50.95	24.9	35.6
0.34085	19.8	13.414	0.73	20.53	14.15	59.18	49.18	38.6	35.0
0.345474	33.159	13.463	0.73	33.89	14.19	59.07	49.07	25.2	34.9
0.37255	28.776	13.178	0.68	29.45	13.86	58.44	48.44	29.0	34.6
0.400874	31.388	12.749	0.61	32.00	13.36	57.84	47.84	25.8	34.5

8 CONCLUSION

In the opinion of ACS, Inc. the RF200A, manufactured by Synapse Wireless, Inc. meets the requirements of FCC Part 15 subpart C and Industry Canada's Radio Standards Specification RSS-210.

END REPORT