Excellence in Compliance Testing

Certification Test Report

FCC ID: U9O-RF200
IC: 7084A-RF200

FCC Rule Part: 15.247
IC Radio Standards Specification: RSS-247

ACS Report Number: 15-2068.W04.1A

Applicant: Synapse Wireless

Model(s): RF200

Test Begin Date: **July 24, 2015**
Test End Date: **September 1, 2015**

Report Issue Date: September 8, 2015

ANAB ACCREDITED ISO/IEC 17025 TESTING LABORATORY

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

Reviewed by:

Thierry Jean-Charles
EMC Engineer
Advanced Compliance Solutions, Inc.

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This report contains 25 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-247 for a Class 2 Permissive Change.

The purpose of the permissive change is to document a new RF switch (part number: UPG2214TB-E4-A) due to obsolescence of previous RF switch and a depopulation of a low pass filter (L6 and C39) on the RF front-end of the module.

1.2 Applicant Information

Synapse Wireless
6723 Odyssey Drive
Huntsville, AL 35806-3301

1.3 Product Description

The Synapse Wireless RF200 Module is an IEEE 802.15.4 compliant RF module that is approved as an FCC Part 15 unlicensed modular transmitter.

Technical Details

Mode of Operation:	IEEE 802.15.4
Frequency Range:	2405 - 2480 MHz
Number of Channels:	16
Channel Separation:	5 MHz
Modulations:	O-QPSK
Antenna Type/Gain:	Pulse 1/4 wavelength dipole, 3.2 dBi
Input Power:	9 VDC

Model Number: RF200

Test Sample Serial Number(s): 5E2BA2

Test Sample Condition: The equipment was provided in good condition without any physical damage.

1.4 Test Methodology and Considerations

The EUT was evaluated for radiated emissions and limited RF conducted measurements while powered through an evaluation board.

The RF conducted measurements were performed on the parameters notably affected by the changes described above. These parameters are the RF Output Power, Band-edge and spurious emissions.

The EUT was evaluated for radiated emissions in three orthogonal orientations. The final measurements were performed using the orientations leading to the highest emissions. The EUT was set one side for the band-edge measurements and flat on the table top for the spurious emissions evaluation.

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 ANAB 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:

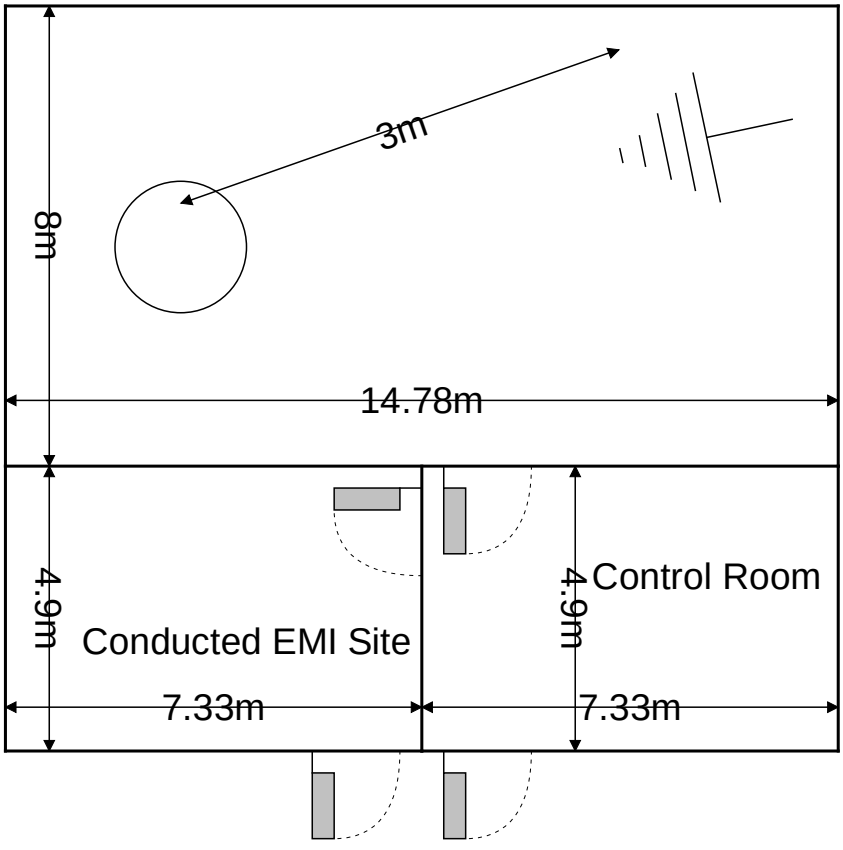


Figure 2.3.1-1: Semi-Anechoic Chamber Test Site

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. The data is 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 evaluations requiring 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:

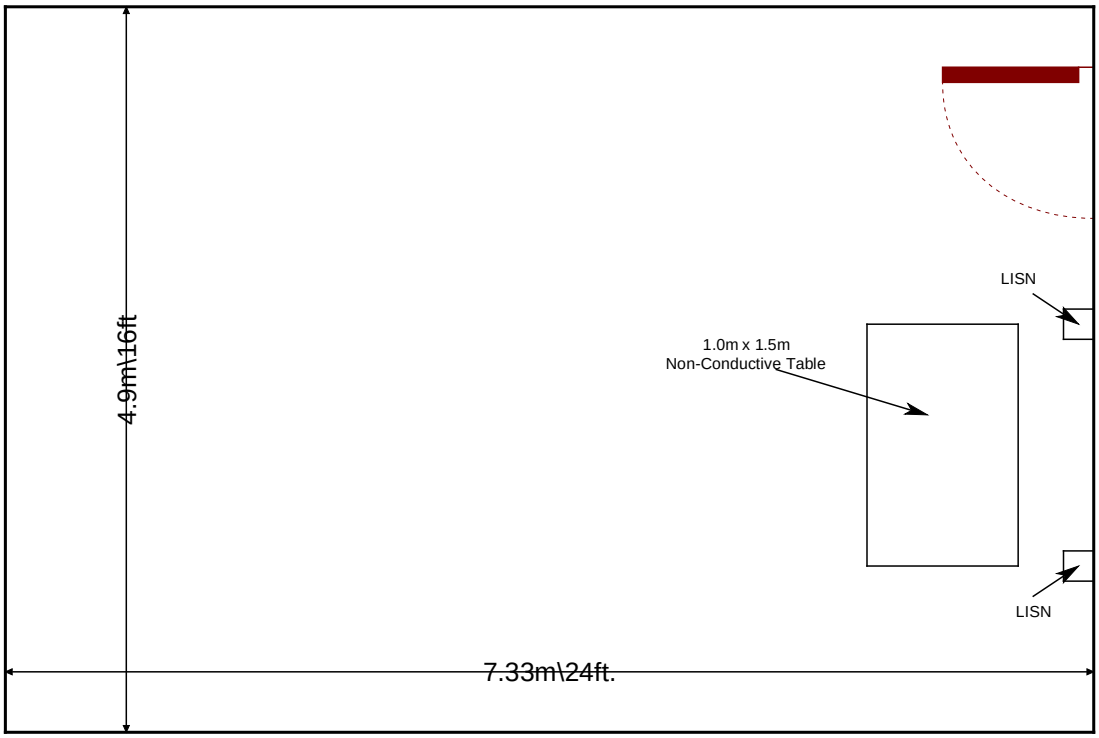


Figure 2.3.2-1: AC Mains Conducted EMI Site

3 APPLICABLE STANDARD REFERENCES

The following standards were used:

- ANSI C63.4-2014: Method of Measurements of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the 9 kHz to 40 GHz.
- ANSI C63.10-2013: American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
- US Code of Federal Regulations (CFR): Title 47, Part 2, Subpart J: Equipment Authorization Procedures, 2015.
- US Code of Federal Regulations (CFR): Title 47, Part 15, Subpart C: Radio Frequency Devices, Intentional Radiators, 2015
- Industry Canada Radio Standards Specification: RSS-247 — Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices, Issue 1, May 2015.
- Industry Canada Radio Standards Specification: RSS-GEN – General Requirements for Compliance of Radio Apparatus, Issue 4, November 2014.

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
78	Suhner	SF-102A	Cables	0944/2A	4/13/2015	4/13/2016
523	Agilent	E7405	Spectrum Analyzers	MY45103293	12/26/2014	12/26/2016
653	EMCO	3108	Antennas	2147	11/22/2013	11/22/2015
2002	EMCO	3146	Antennas	1385	11/22/2013	11/22/2015
2004	EMCO	3146	Antennas	1385	11/22/2013	11/22/2015
2006	EMCO	3115	Antennas	2573	4/14/2015	4/14/2017
2008	COM-Power	AH-826	Antennas	81009	NCR	NCR
2011	Hewlett-Packard	HP 8447D	Amplifiers	2443A03952	12/31/2014	12/31/2015
2037	ACS Boca	Chamber EMI Cable Set	Cable Set	2037	2/17/2015	2/17/2016
2070	Mini Circuits	VHF-8400+	Filter	2070	12/31/2014	12/31/2015
2072	Mini Circuits	VHF-3100+	Filter	30737	12/31/2014	12/31/2015
2082	Teledyne Storm Products	90-010-048	Cables	2082	4/22/2015	4/22/2016
2086	Merrimac	FAN-6-10K	Attenuators	23148-83-1	12/31/2014	12/31/2015
2089	Agilent Technologies, Inc.	83017A	Amplifiers	3123A00214	12/12/2014	12/12/2015
2095	ETS Lindgren	TILE4! - Version 4.2.A	Software	85242	NCR	NCR
283	Rohde & Schwarz	FSP40	Spectrum Analyzers	1000033	9/8/2013	9/18/2015
2111	Aeroflex Inmet	40AH2W-20	Attenuator	2111	7/22/2015	7/22/2016

NCR=No Calibration Required

5 SUPPORT EQUIPMENT

Table 5-1: EUT and Support Equipment

Item #	Type Device	Manufacturer	Model/Part #	Serial #
1	EUT	Synapse Wireless	RF200	5E2BA2
2	Interface Board	Synapse Wireless	SN171 Protoboard	158110002
3	9VDC AC Adapter	Tamura Corp.	318AS09035	0705

Table 5-2: Cable Description

Cable #	Cable Type	Length	Shield	Termination
A	Power	1.97 m	NO	EUT to Power Supply
B	Extension Cable	2.7 m	NO	Power Supply to AC Mains

6 EQUIPMENT UNDER TEST SETUP BLOCK DIAGRAM

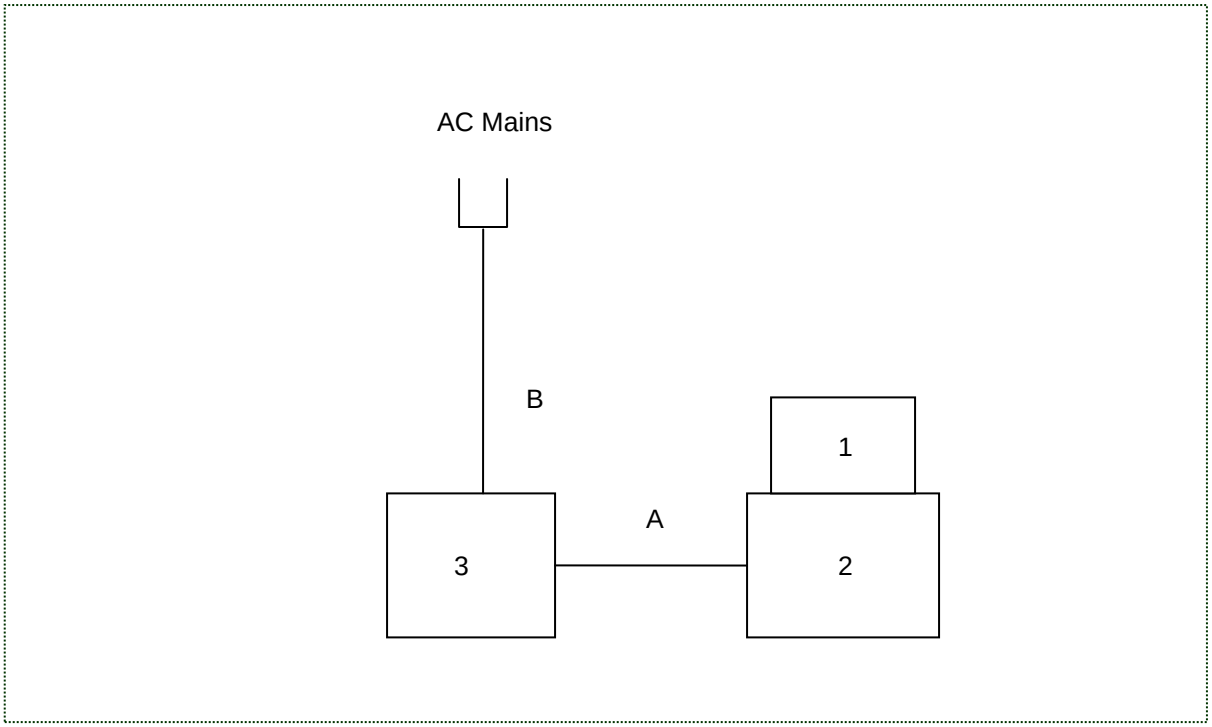


Figure 6-1: EUT Test Setup

7 SUMMARY OF TESTS

Along with the tabular data shown below, plots were taken of all signals deemed important enough to document.

7.1 Antenna Requirement – FCC: Section 15.203

The RF200 uses a 1/4 wavelength dipole antenna with a measureed gain of 3.2 dBi. The coupling is R-SMA thus statisfying the requirements of FCC 47 CFR Section 15.203.

7.2 Peak Output Power - FCC Section 15.247(b)(3) IC: RSS-247 A8.4(4)

7.2.1 Measurement Procedure (Conducted Method)

The Peak Output Power was measured in accordance with ANSI C63.10:2013 Section 11.9.1 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.

7.2.2 Measurement Results

Results are shown below.

Table 7.2.2-1: RF Output Power

Frequency [MHz]	Level [dBm]
2405	14.17
2440	13.13
2475	9.46
2480	0.00

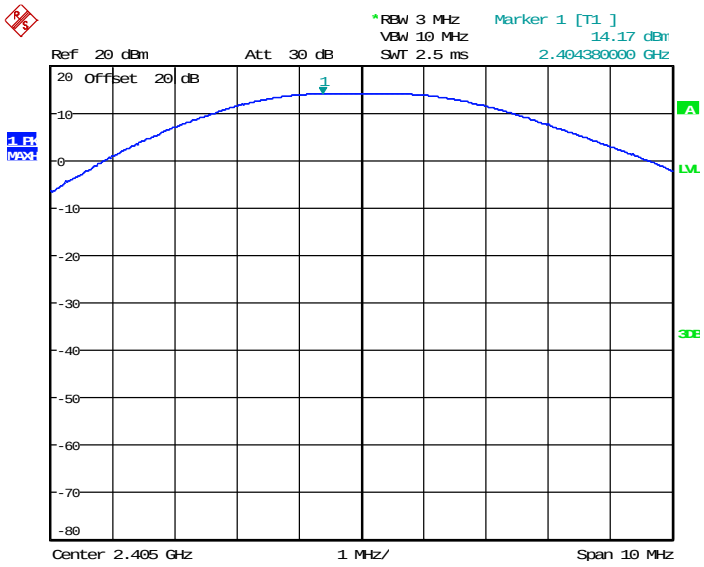


Figure 7.2.2-1: RF Output Power – 2405 MHz

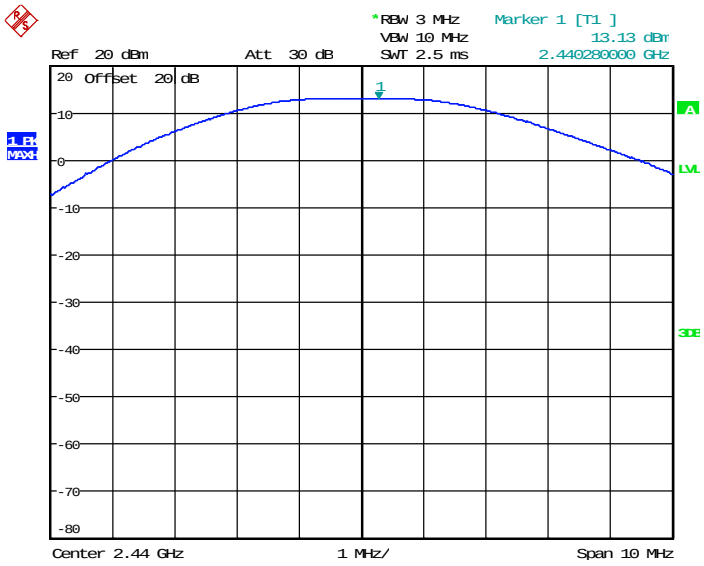
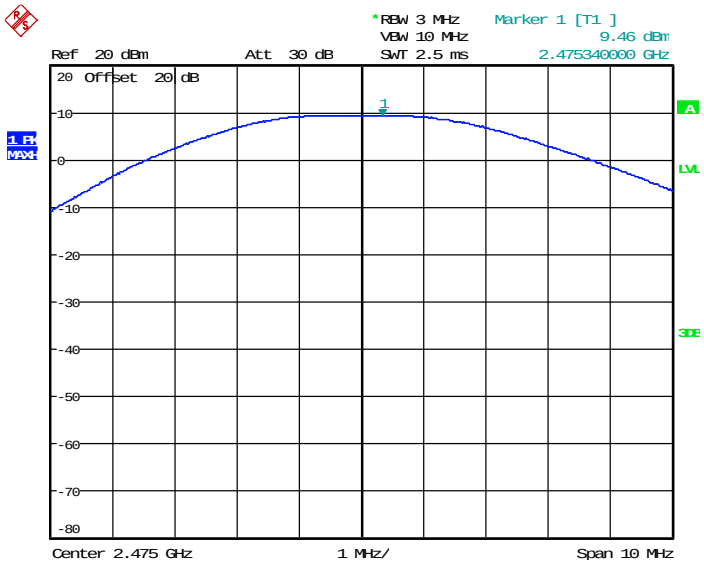
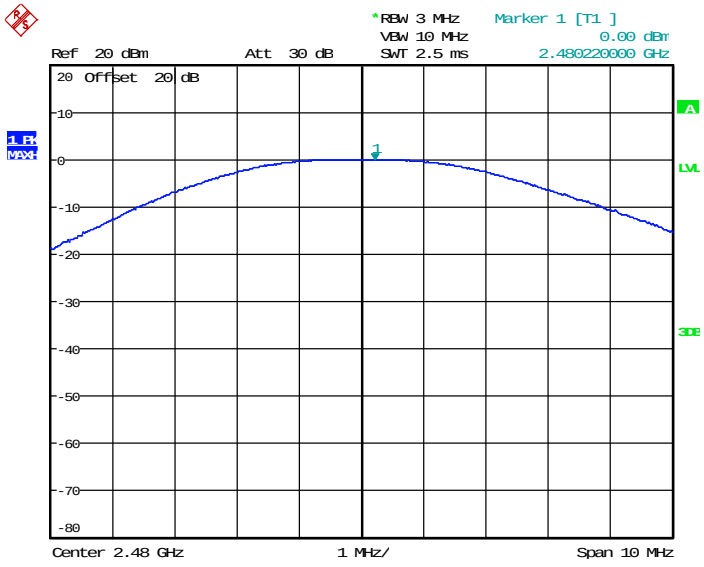


Figure 7.2.2-2: RF Output Power – 2440 MHz



Date: 31.AUG.2015 13:22:14

Figure 7.2.2-3: RF Output Power – 2475 MHz



Date: 31.AUG.2015 13:25:02

Figure 7.2.2-4: RF Output Power – 2480 MHz

7.3 Band-Edge Compliance and Spurious Emissions-FCC 15.247(d) IC: RSS-247 5.5

7.3.1 Band-Edge Compliance of RF Conducted Emissions

7.3.1.1 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.

7.3.1.2 Measurement Results

Results are shown below.

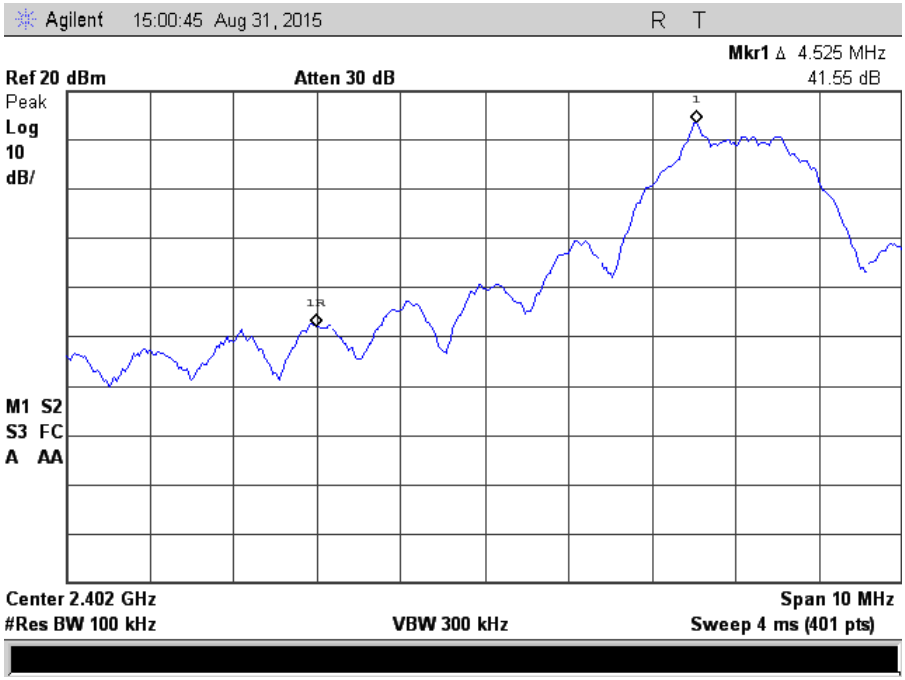


Figure 7.3.1.2-1: Band-edge – 2405 MHz

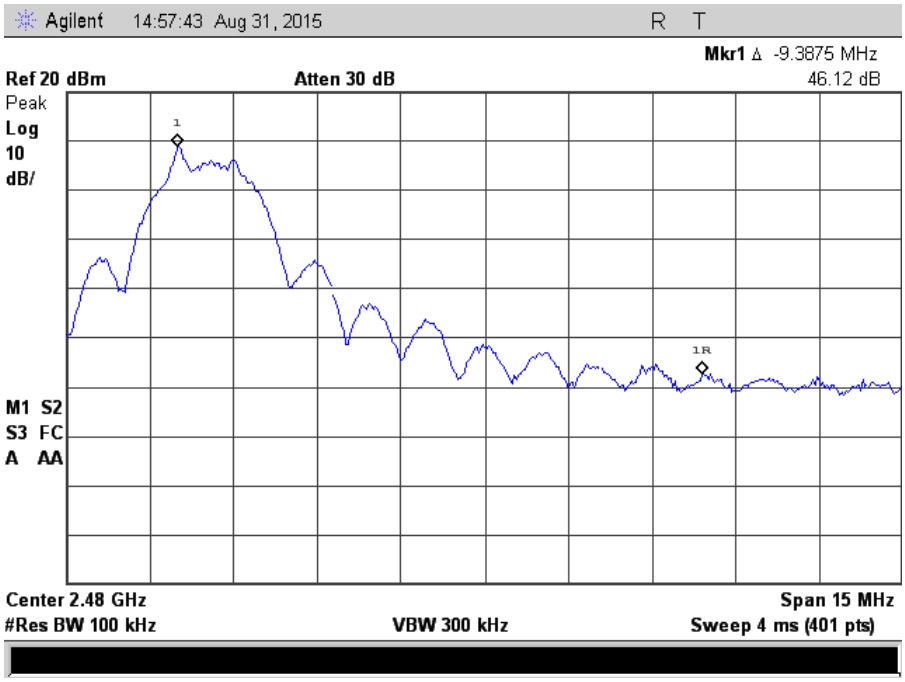


Figure 7.3.1.2-2: Band-edge – 2475 MHz

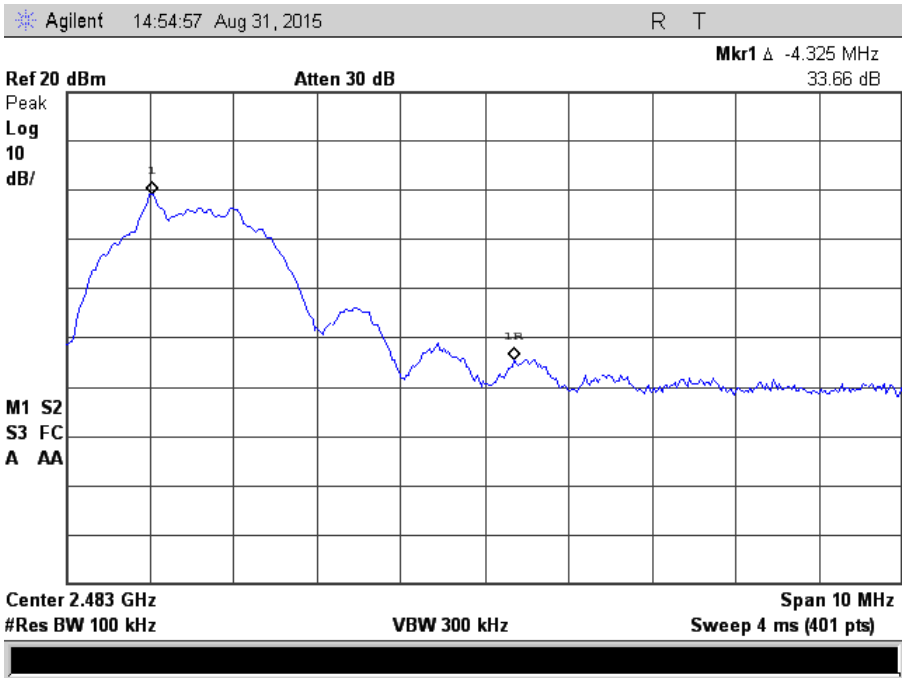


Figure 7.3.1.2-3: Band-edge – 2480 MHz

7.3.2 RF Conducted Spurious Emissions

7.3.2.1 Measurement Procedure

The RF Conducted Spurious Emissions were measured in accordance with ANSI C63.10:2013 Section 11.11 Emissions in nonrestricted frequency bands. 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 30 MHz 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. The reference level was determined by measuring the Peak PSD level in any 100 kHz bandwidth within the DTS channel bandwidth.

7.3.2.2 Measurement Results

Results are shown below.

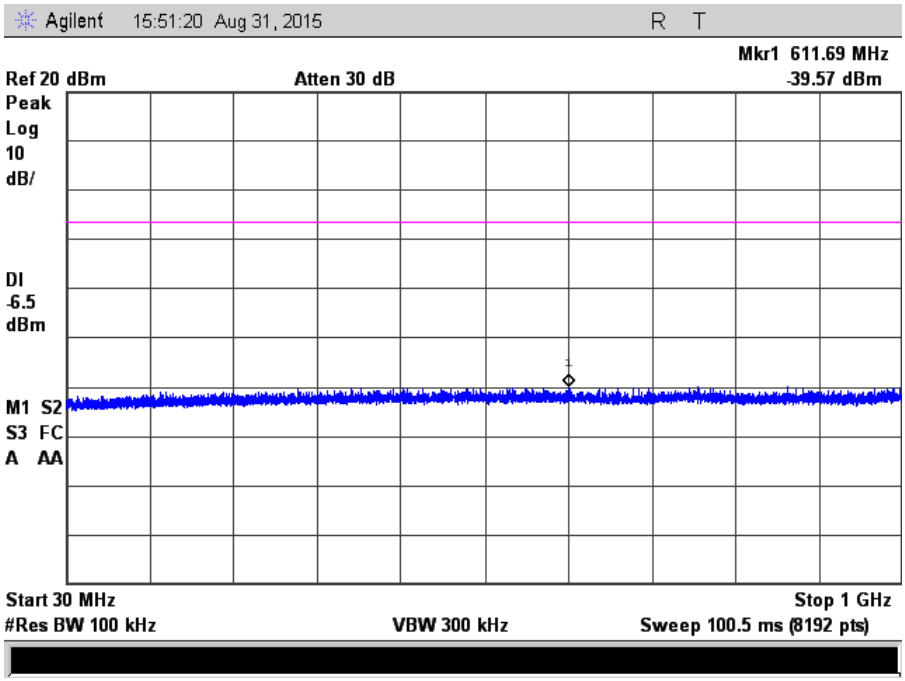


Figure 7.3.2.2-1: 30 MHz – 1 GHz – 2405 MHz

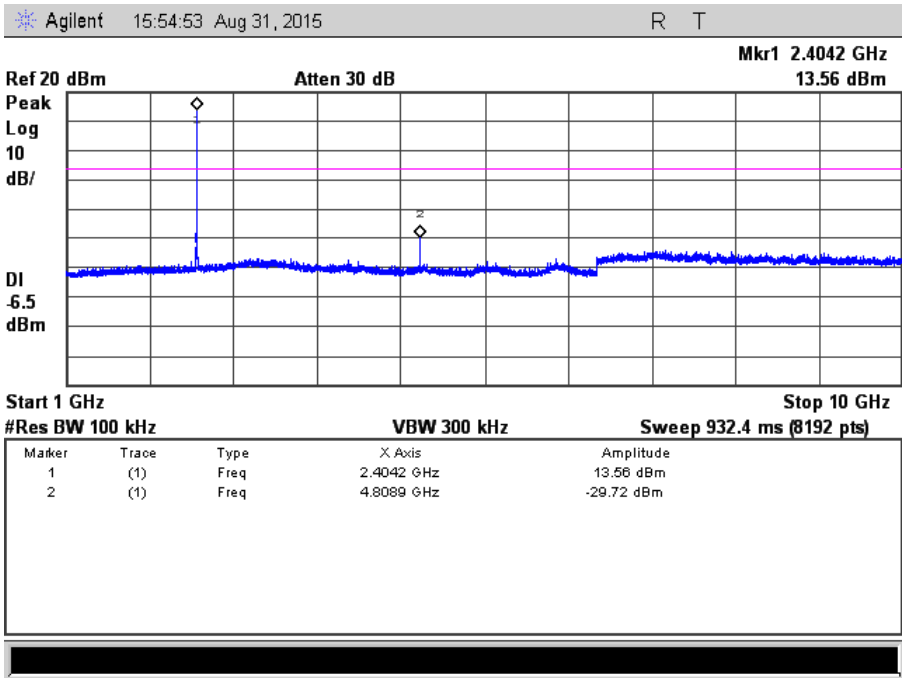


Figure 7.3.2.2-2: 1 GHz –10 GHz – 2405 MHz

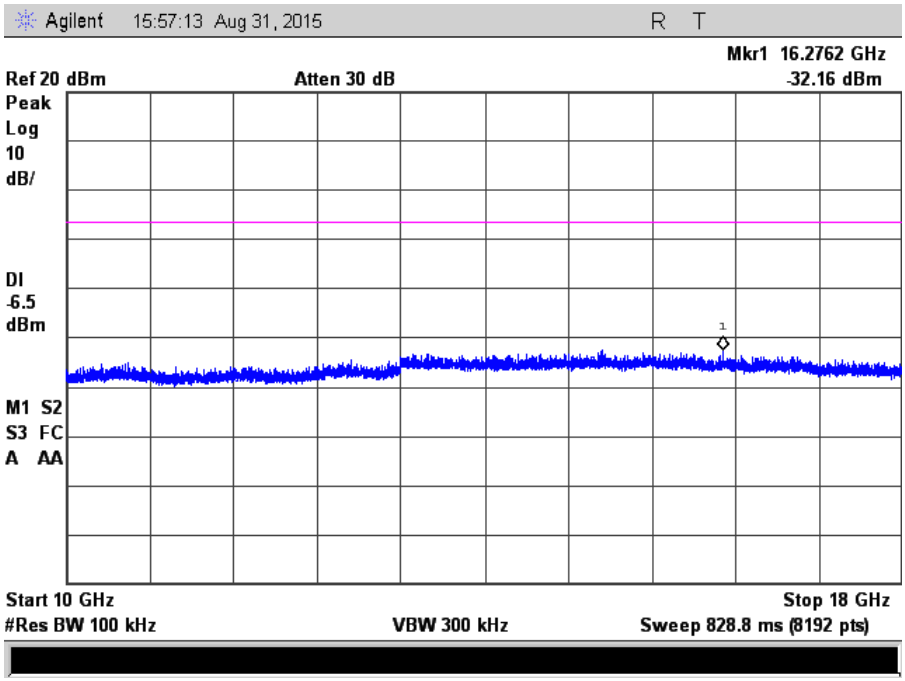


Figure 7.3.2.2-3: 10 GHz –18 GHz – 2405 MHz

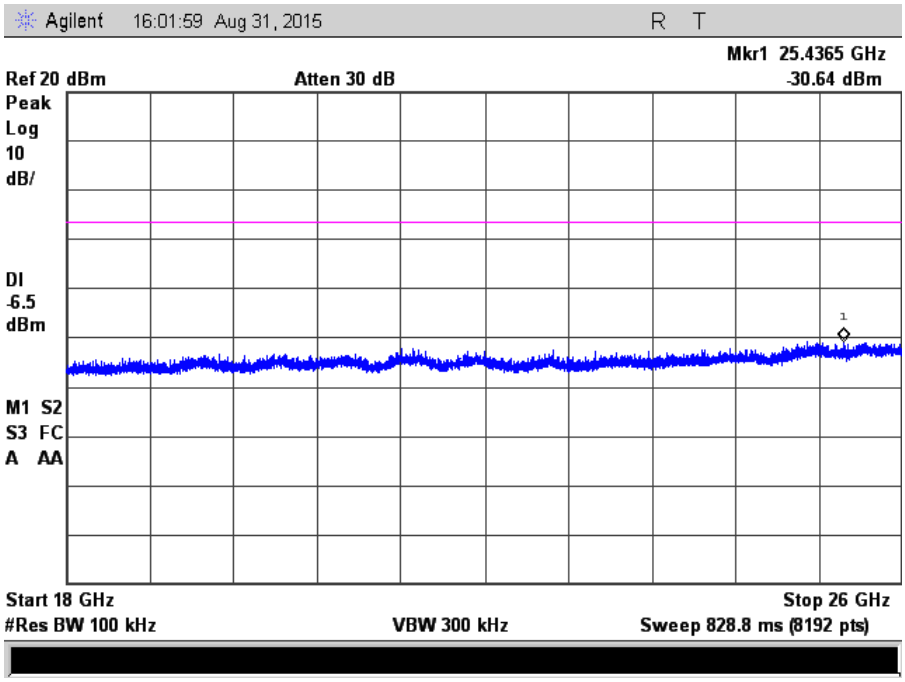


Figure 7.3.2.2-4: 18 GHz – 26 GHz –2405 MHz

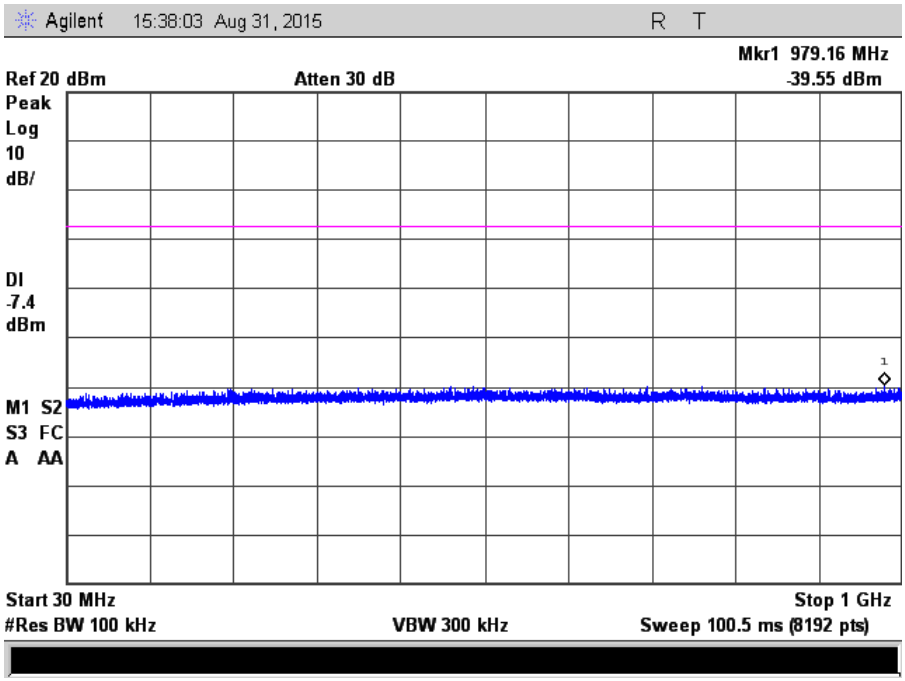


Figure 7.3.2.2-5: 30 MHz – 1 GHz – 2440 MHz

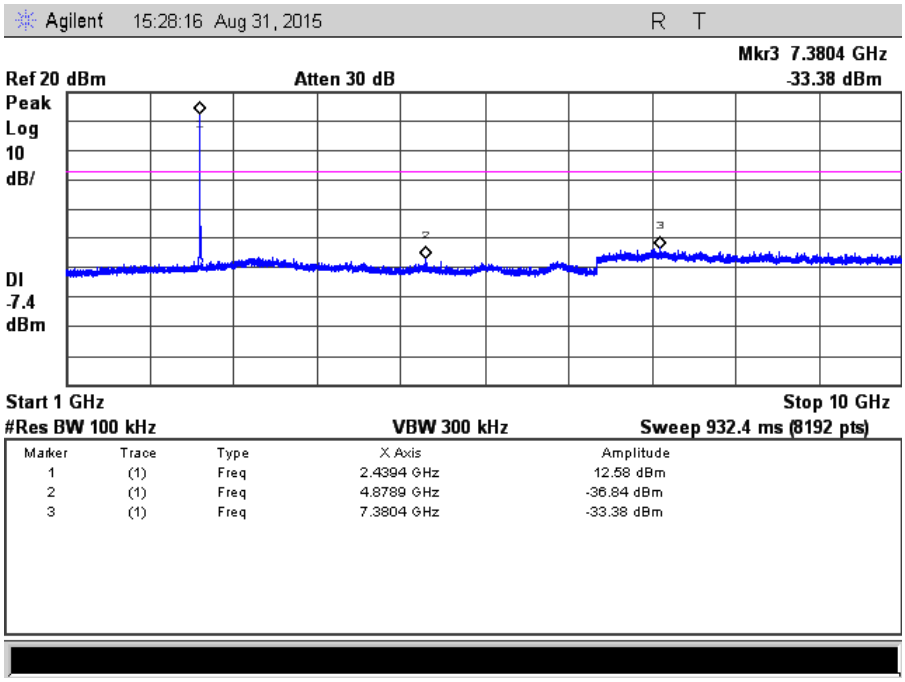


Figure 7.3.2.2-6: 1 GHz –10 GHz – 2440 MHz

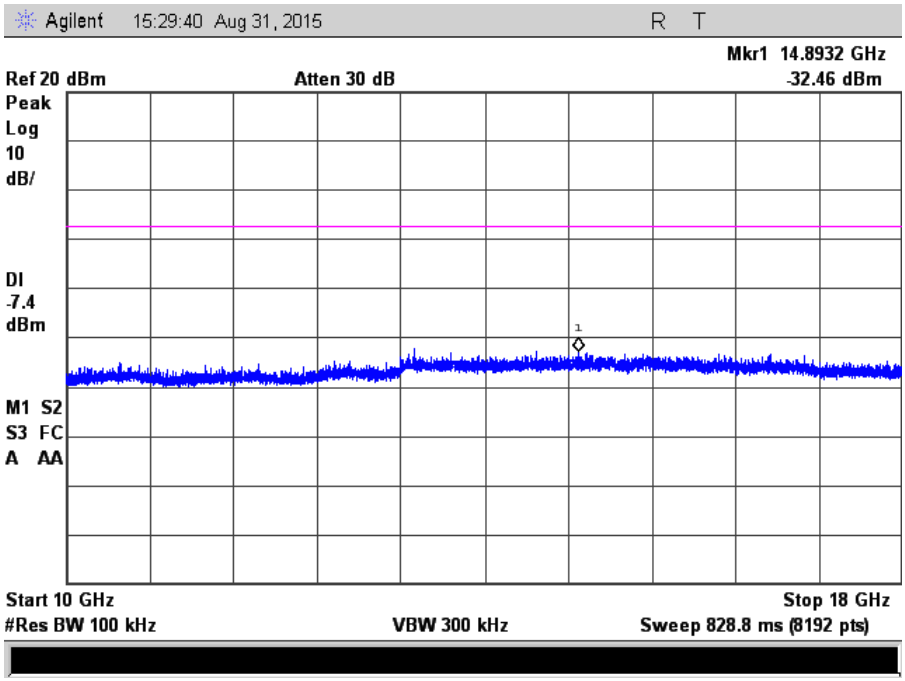


Figure 7.3.2.2-7: 10 GHz –18 GHz – 2440 MHz

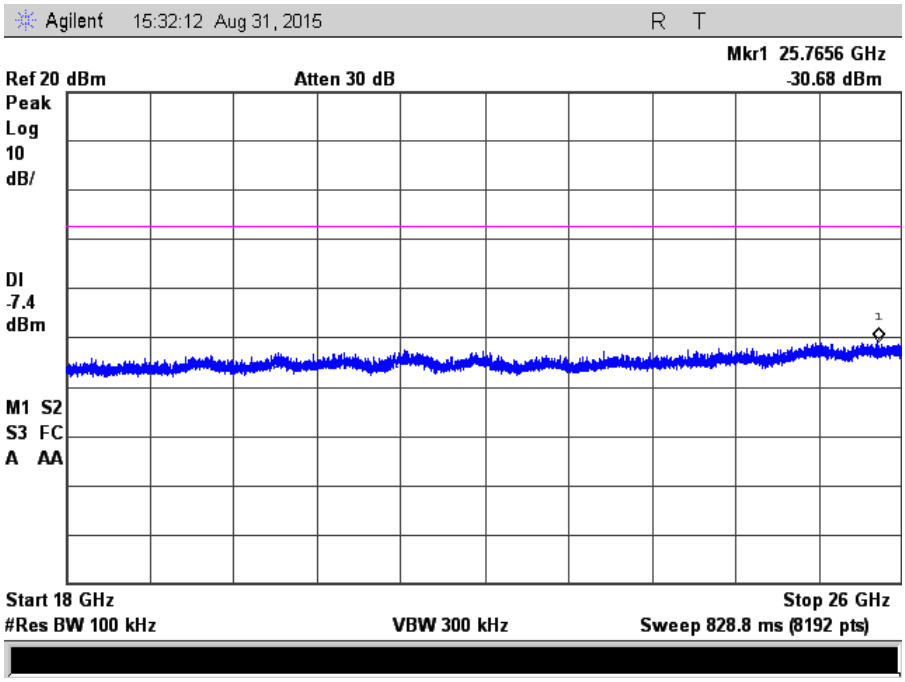


Figure 7.3.2.2-8: 18 GHz – 26 GHz – 2440 MHz

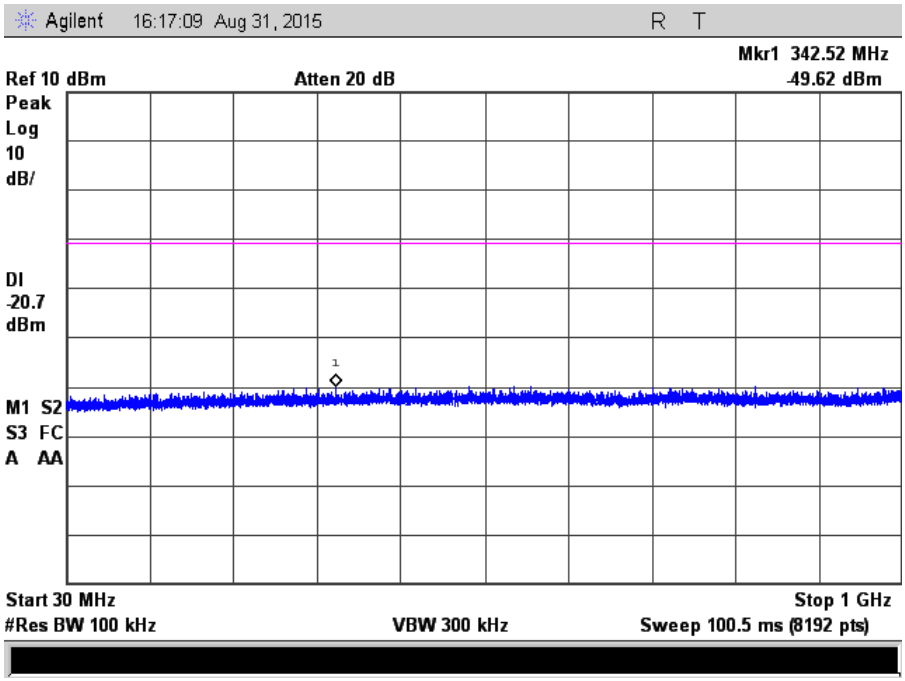


Figure 7.3.2.2-9: 30 MHz – 1 GHz – 2480 MHz

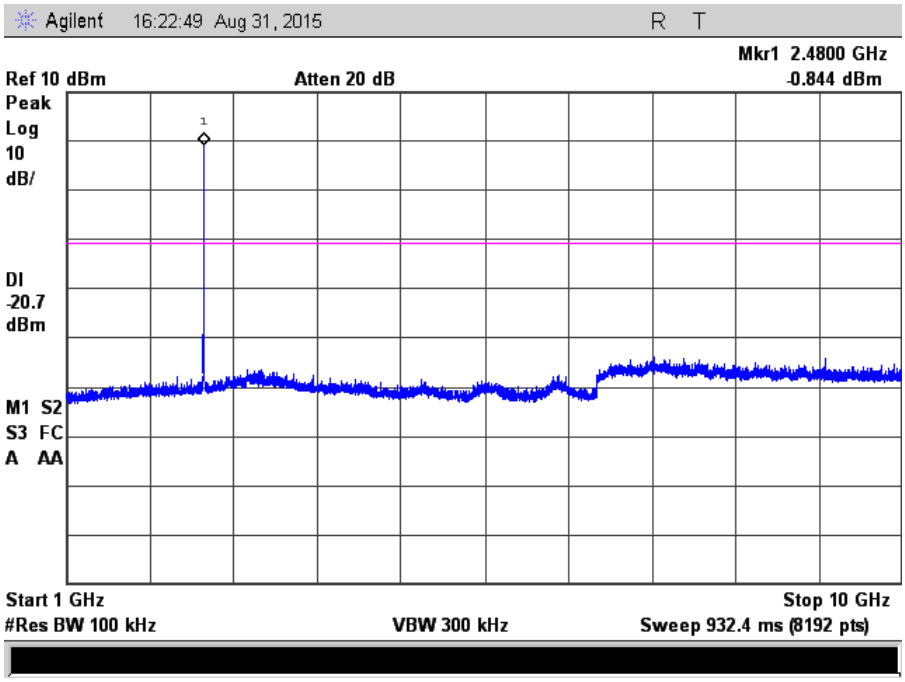


Figure 7.3.2.2-10: 1 GHz –10 GHz – 2480 MHz

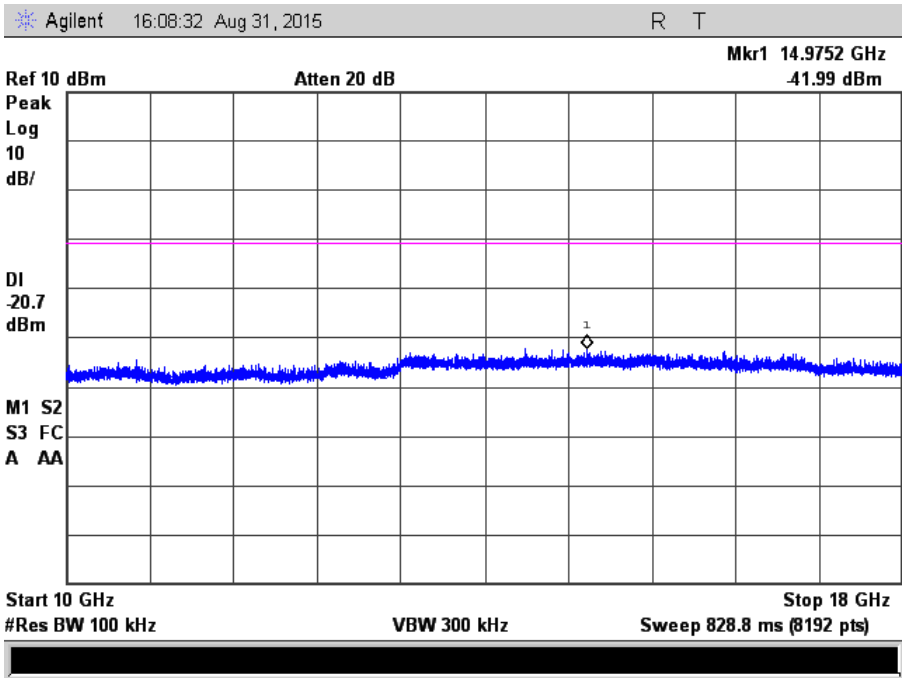


Figure 7.3.2.2-11: 10 GHz – 18 GHz – 2480 MHz

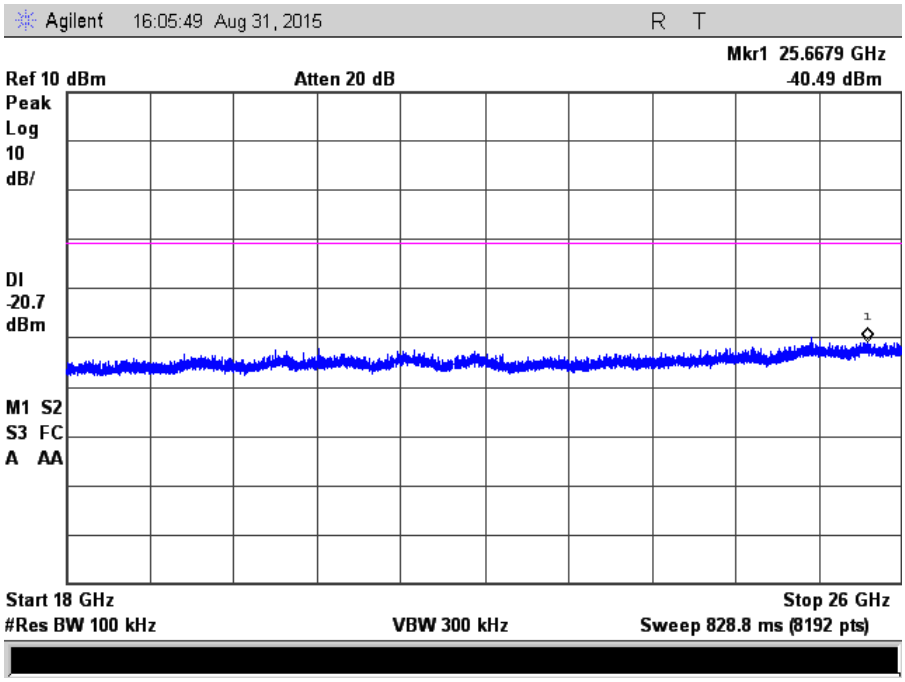


Figure 7.3.2.2-12: 18 GHz – 26 GHz – 2480 MHz

7.3.3 Radiated Spurious Emissions into Restricted Frequency Bands - FCC 15.205, 15.209; IC: RSS-Gen 8.9, 8.10

7.3.3.1 Measurement Procedure

Radiated emissions tests were made over the frequency range of 9 kHz to 26 GHz, 10 times the highest fundamental frequency. Each emission found to be in a restricted band as defined by section 15.205, including any emission at the operational band-edge, was compared to the radiated emission limits as defined in section 15.209.

For measurements below 30 MHz, the receive antenna height was set to 1m and the EUT was rotated through 360 degrees. The resolution bandwidth was set to 200 Hz below 150 kHz and to 9 kHz above 150 kHz.

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 1000 MHz, quasi-peak measurements were made using a resolution bandwidth RBW of 120 kHz and a video bandwidth VBW of 300 kHz. For frequencies above 1000 MHz, peak measurements are made with RBW of 1 MHz and VBW of 3 MHz. Average measurements are performed in the linear scale using VBW of 30 Hz over a 5 second sweep.

7.3.3.2 Measurement Results

Radiated band-edge and spurious emissions found in the restricted frequency bands of 9 kHz to 26 GHz are reported in the tables below.

Table 7.3.3.2-1: 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	61.61	48.73	H	-6.63	54.98	25.08	74.0	54.0	19.0	28.9
2390	66.27	56.93	V	-6.63	59.64	33.28	74.0	54.0	14.4	20.7
4810	56.07	48.48	H	1.62	57.69	33.09	74.0	54.0	16.3	20.9
4810	62.15	55.71	V	1.62	63.77	40.32	74.0	54.0	10.2	13.7
12025	52.03	44.05	H	13.58	65.61	40.61	83.5	63.5	17.9	22.9
12025	57.01	50.18	V	13.58	70.59	46.74	83.5	63.5	12.9	16.8
19240	47.10	37.67	H	10.96	58.06	31.61	83.5	63.5	25.4	31.9
19240	46.90	36.27	V	10.96	57.86	30.21	83.5	63.5	25.6	33.3
Middle Channel = 2440 MHz										
4880	54.57	48.28	H	1.85	56.42	33.11	74.0	54.0	17.6	20.9
4880	58.71	53.02	V	1.85	60.56	37.85	74.0	54.0	13.4	16.1
7320	59.78	52.95	H	6.19	65.97	42.13	74.0	54.0	8.0	11.9
7320	64.28	58.11	V	6.19	70.47	47.29	74.0	54.0	3.5	6.7
12200	52.58	43.14	H	13.66	66.24	39.79	83.5	63.5	17.3	23.7
12200	55.34	47.06	V	13.66	69.00	43.71	83.5	63.5	14.5	19.8
19520	43.42	30.28	V	11.21	54.63	24.47	83.5	63.5	28.9	39.0
Next to High Channel = 2475 MHz										
2483.5	59.81	48.42	H	-6.21	53.60	25.20	74.0	54.0	20.4	28.8
2483.5	69.49	59.30	V	-6.21	63.28	36.08	74.0	54.0	10.7	17.9
4950	49.44	39.84	H	2.08	51.52	24.90	74.0	54.0	22.5	29.1
4950	52.24	44.49	V	2.08	54.32	29.55	74.0	54.0	19.7	24.4
7425	53.83	45.57	H	6.47	60.30	35.02	74.0	54.0	13.7	19.0
7425	54.77	47.13	V	6.47	61.24	36.58	74.0	54.0	12.8	17.4
12375	45.94	33.39	H	13.75	59.69	30.12	83.5	63.5	23.8	33.4
12375	48.32	37.26	V	13.75	62.07	33.99	83.5	63.5	21.4	29.5
High Channel = 2480 MHz										
2483.5	63.84	52.90	H	-6.21	57.63	29.68	74.0	54.0	16.4	24.3
2483.5	74.88	65.56	V	-6.21	68.67	42.34	74.0	54.0	5.3	11.7
4960	45.92	33.16	H	2.11	48.03	18.26	74.0	54.0	26.0	35.7
4960	46.33	33.54	V	2.11	48.44	18.64	74.0	54.0	25.6	35.4
7440	46.12	33.19	V	6.51	52.63	22.68	74.0	54.0	21.4	31.3

Notes:

- **All radiated emissions above 19.5 GHz were attenuated below the limits and the noise floor of the test equipment.**
- **The average measurements were further corrected using a duty cycle correction factor of 20*log(14.1/100) = 17.02 dB. The justification for the duty cycle correction factor is documented in the equipment Theory of Operation Document.**

7.3.3.3 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

DC = 20*log(14.1/100) = -17.02 dB

Example Calculation: Peak
Corrected Level: 61.61+ -6.63 = 54.98 dBµV/m
Margin: 74 dBµV/m – 54.98 dBµV/m = 19.0 dB

Example Calculation: Average
Corrected Level: 48.73 + (-6.63) - 17.02 = 25.08 dBµV/m
Margin: 54 dBµV/m – 25.08 dBµV/m = 28.9 dB

8 CONCLUSION

In the opinion of ACS, Inc., the model RF200 manufactured by Synapse Wireless meets the requirements of FCC Part 15 subpart C and Industry Canada's Radio Standards Specification RSS-247 for the test procedures documented in the test report.

END REPORT