Excellence in Compliance Testing

Certification Test Report

FCC ID: R7PER6R1S2

FCC Rule Part: 15.247

ACS Report Number: 15-0174.W03.1A

Manufacturer: Landis+Gyr Technology, Inc.
Model: M120

Test Begin Date: May 6, 2015
Test End Date: May 7, 2015

Report Issue Date: June 11, 2015

FOR THE SCOPE OF ACCREDITATION UNDER LAB Code 200612-0

This report is not be used to claim certification, approval, or endorsement by NVLAP, NIST or any government agency.

Reviewed by:
Kirby Munroe
Director, Wireless Certifications
ACS, Inc.

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 for modular approval certification.

1.2 Product description

The M120 is a battery operated module operating in the 902 – 928 MHz frequency band. The M120 is designed for automated gas meter reading and has a 2-way radio that is compatible with electric meters, routers, and mesh extenders for relaying sensor data to the utility.

Technical Information:
The model M120 provides two distinct modes of operation; frequency hopping mode at high power, and single channel mode at low power. This report addresses the frequency hopping mode as outlined below.

Mode of Operation	Frequency Range (MHz)	Number of Channels	Channel Separation (kHz)	Data Rates Supported (kbps)
1	902.3 - 927.8	86	300	9.6, 19.2, 38.4, 115.2
2	904.0 - 927.9	240	100	9.6, 19.2, 38.4

Modulation Format: FSK/GFSK
Antenna Type / Gain: Inverted F / 2dBi gain
Operating Voltage: 3VDC (Internal Battery)

Manufacturer Information:
Landis+Gyr Technology, Inc.
30000 Mill Creek Ave., Suite 100
Alpharetta, GA 30022

EUT Serial Numbers: E050D14100000333 (Radiated), E050D141500000029 (RF Conducted)

Test Sample Condition: The test samples were provided in good working order with no visible defects.

1.3 Test Methodology and Considerations

All modes of operation, including all available data rates, were evaluated. The data presented in this report represents the worst case where applicable.

For radiated emissions, the EUT was evaluated in three orthogonal orientations. The worst case orientation was Y-orientation.

The EUT is battery operated; therefore, AC power-line conducted emissions are not applicable.

Software power setting during test (900 MHz Radio): 8E

2 TEST FACILITIES

2.1 Location

The radiated and conducted emissions test sites are located at the following address:

Advanced Compliance Solutions
5015 B.U. Bowman Drive
Buford, GA 30518
Phone: (770) 831-8048
Fax: (770) 831-8598

2.2 Laboratory Accreditations/Recognitions/Certifications

ACS is accredited to ISO/IEC 17025 by the National Institute of Standards and Technology under their National Voluntary Laboratory Accreditation Program (NVLAP), Lab Code 200612-0. Unless otherwise specified, all tests methods described within this report are covered under the ISO/IEC 17025 scope of accreditation.

The Semi-Anechoic Chamber Test Site, Open Area Test Site (OATS) and Conducted Emissions Site have been fully described, submitted to, and accepted by the FCC, Industry Canada and the Japanese Voluntary Control Council for Interference by information technology equipment.

FCC Registration Number: 511277
Industry Canada Lab Code: IC 4175A
VCCI Member Number: 1831

- VCCI OATS Registration Number R-1526
- VCCI Conducted Emissions Site Registration Number: C-1608

2.3 Radiated Emissions Test Site Description

2.3.1 Semi-Anechoic Chamber Test Site

The Semi-Anechoic Chamber Test Site consists of a 20' x 30' x 18' shielded enclosure. The chamber is lined with Toyo Ferrite Grid Absorber, model number FFG-1000. The ferrite tile grid is 101 x 101 x 19mm thick and weighs approximately 550 grams. These tiles are mounted on steel panels and installed directly on the inner walls of the chamber.

The turntable is 150cm in diameter and is located 160cm from the back wall of the chamber. The chamber is grounded via 1 – 8' copper ground rod, installed at the center of the back wall, it is bound to the ground plane using 3/4" stainless steel braided cable.

The turntable is all steel, flush mounted table installed in an all steel frame. The table is remotely operated from inside the control room located 25' from the range. The turntable is electrically bonded to the surrounding ground plane via steel fingers installed on the edge of the turn table. The steel fingers make constant contact with the ground plane during operation.

Behind the turntable is a 3' x 6' x 4' deep shielded pit used for support equipment if necessary. The pit is equipped with 1 – 4" PVC chases from the turntable to the pit that allow for cabling to the EUT if necessary. The underside of the turntable can be accessed from the pit so cables can be supplied to the EUT from the pit.

A diagram of the Semi-Anechoic Chamber Test Site is shown in Figure 2.3-1 below:

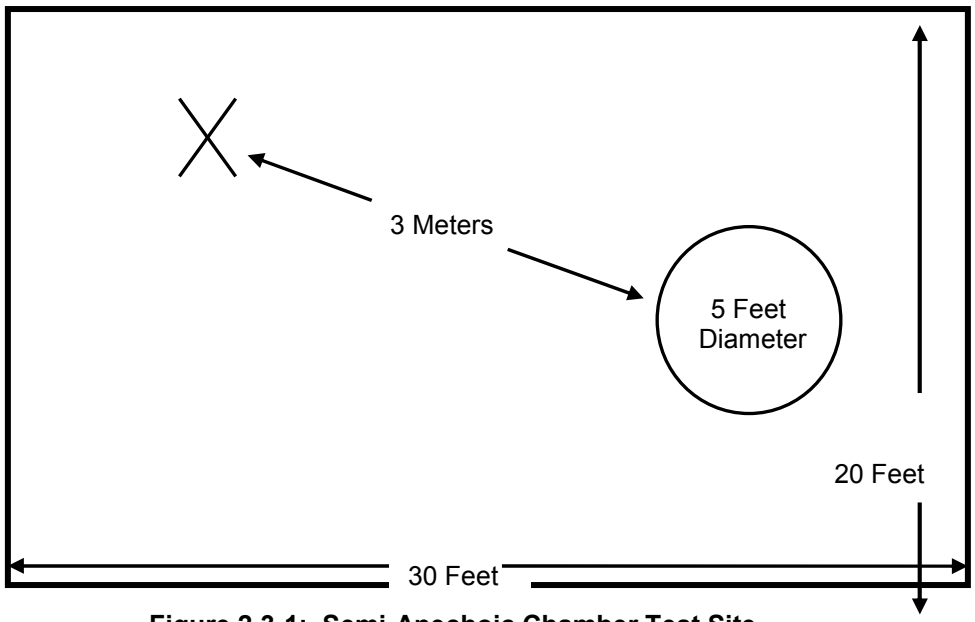

Figure 2.3-1: Semi-Anechoic Chamber Test Site

2.3.2 Open Area Tests Site (OATS)

The open area test site consists of a 40' x 66' concrete pad covered with a perforated electro-plated galvanized sheet metal. The perforations in the sheet metal are 1/8" holes that are staggered every 3/16". The individual sheets are placed to overlap each other by 1/4" and are riveted together to provide a continuous seam. Rivets are spaced every 3" in a 3 x 20 meter perimeter around the antenna mast and EUT area. Rivets in the remaining area are spaced as necessary to properly secure the ground plane and maintain the electrical continuity.

The entire ground plane extends 12' beyond the turntable edge and 16' beyond the antenna mast when set to a 10 meter measurement distance. The ground plane is grounded via 4 – 8' copper ground rods, each installed at a corner of the ground plane and bound to the ground plane using 3/4" stainless steel braided cable.

The turntable is an all aluminum 10' flush mounted table installed in an all aluminum frame. The table is remotely operated from inside the control room located 40' from the range. The turntable is electrically bonded to the surrounding ground plane via steel fingers installed on the edge of the turn table. The steel fingers make constant contact with the ground plane during operation.

Adjacent to the turntable is a 7' x 7' square and 4' deep concrete pit used for support equipment if necessary. The pit is equipped with 5 – 4" PVC chases from the pit to the control room that allow for cabling to the EUT if necessary. The underside of the turntable can be accessed from the pit so cables can be supplied to the EUT from the pit. The pit is covered with 2 sheets of 1/4" diamond style re-enforced steel sheets. The sheets are painted to match the perforated steel ground plane; however the underside edges have been masked off to maintain the electrical continuity of the ground plane. All reflecting objects are located outside of the ellipse defined in ANSI C63.4.

A diagram of the Open Area Test Site is shown in Figure 2.3-2 below:

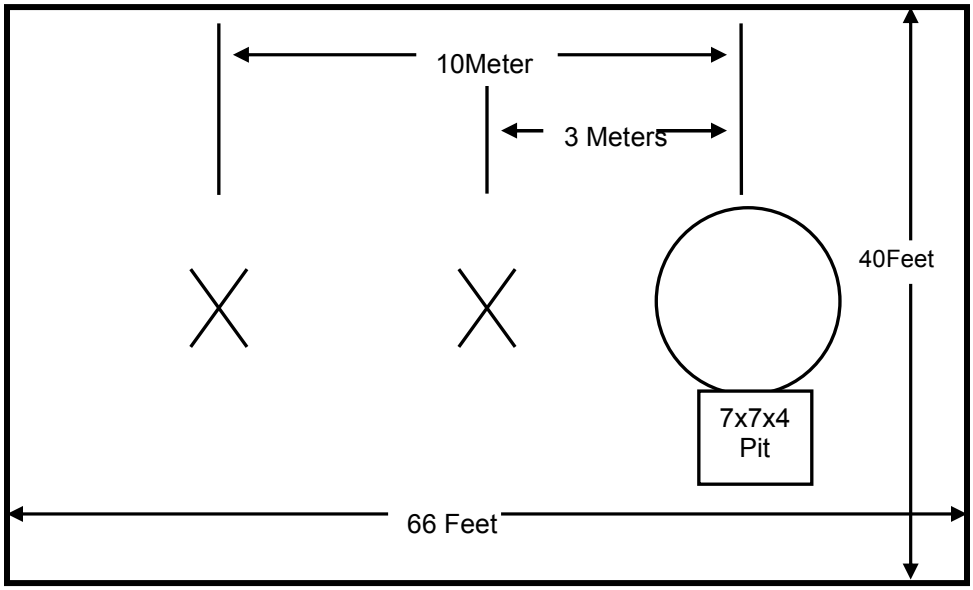

Figure 2.3-2: Open Area Test Site

2.4 Conducted Emissions Test Site Description

The AC mains conducted EMI site is located in the main EMC lab. It consists of an 8' x 8' solid aluminum horizontal ground reference plane (GRP) bonded every 3" to an 8' X 8' vertical ground plane.

The site is of sufficient size to test table top and floor standing equipment in accordance with section 6.1.4 of ANSI C63.4.

A diagram of the room is shown below in figure 2.4-1:

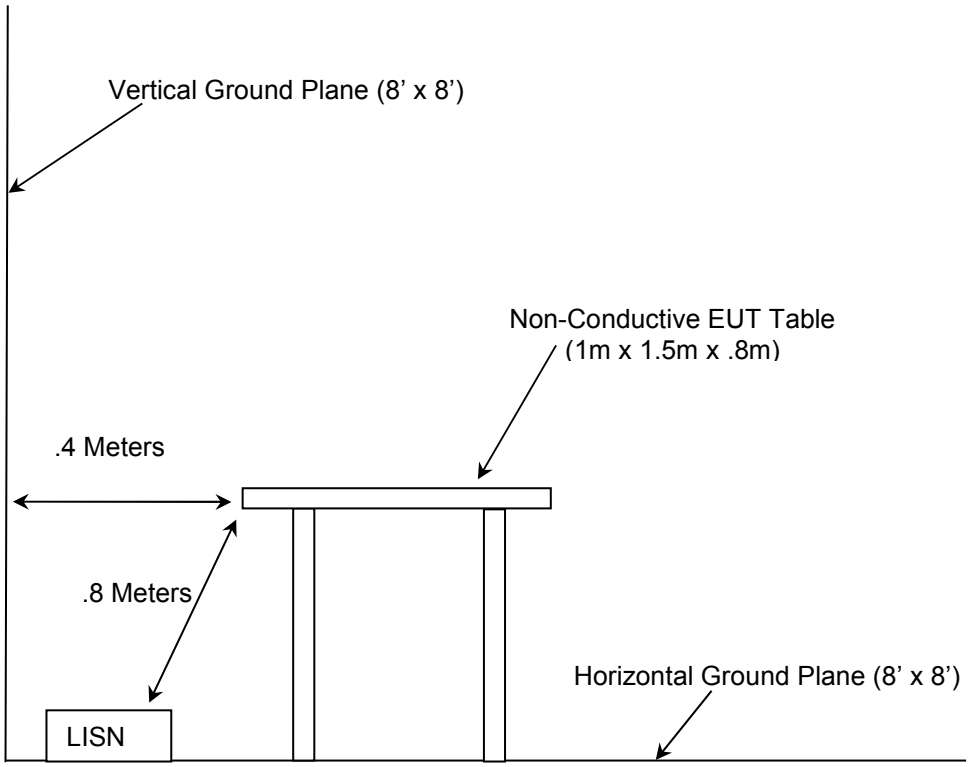

Figure 2.4-1: AC Mains Conducted EMI Site

3 APPLICABLE STANDARD REFERENCES

The following standards were used:

- 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, 2015
- US Code of Federal Regulations (CFR): Title 47, Part 15, Subpart C: Radio Frequency Devices, Intentional Radiators, 2015
- FCC Public Notice DA 00-705 – Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems, March 30, 2000

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
1	Rohde & Schwarz	ESMI - Display	Spectrum Analyzers	833771/007	7/11/2014	7/11/2015
2	Rohde & Schwarz	ESMI-Receiver	Spectrum Analyzers	839587/003	7/11/2014	7/11/2015
40	EMCO	3104	Antennas	3211	2/10/2015	2/10/2017
73	Agilent	8447D	Amplifiers	2727A05624	7/15/2014	7/15/2015
167	ACS	Chamber EMI Cable Set	Cable Set	167	10/28/2014	10/28/2015
267	Agilent	N1911A	Meters	MY45100129	7/30/2013	7/30/2015
268	Agilent	N1921A	Sensors	MY45240184	7/30/2013	7/30/2015
292	Florida RF Cables	SMR-290AW-480.0-SMR	Cables	None	3/3/2015	3/3/2016
329	A.H.Systems	SAS-571	Antennas	721	7/15/2013	7/15/2015
331	Microwave Circuits	H1G513G1	Filters	31417	6/2/2014	6/2/2015
338	Hewlett Packard	8449B	Amplifiers	3008A01111	7/30/2013	7/30/2015
340	Aeroflex/Weinschel	AS-20	Attenuators	7136	7/14/2014	7/14/2015
412	Electro Metrics	LPA-25	Antennas	1241	7/24/2014	7/24/2016
422	Florida RF	SMS-200AW-72.0-SMR	Cables	805	11/5/2014	11/5/2015
616	Florida RF Cables	SMRE-200W-12.0-SMRE	Cables	N/A	9/10/2014	9/10/2015
622	Rohde & Schwarz	FSV40	Analyzers	101338	7/12/2014	7/12/2015

5 SUPPORT EQUIPMENT

Table 5-1: Support Equipment

Item	Equipment Type	Manufacturer	Model Number	Serial Number
1	Battery	Landis + Gyr	40-1235	N/A

6 EQUIPMENT UNDER TEST SETUP BLOCK DIAGRAM

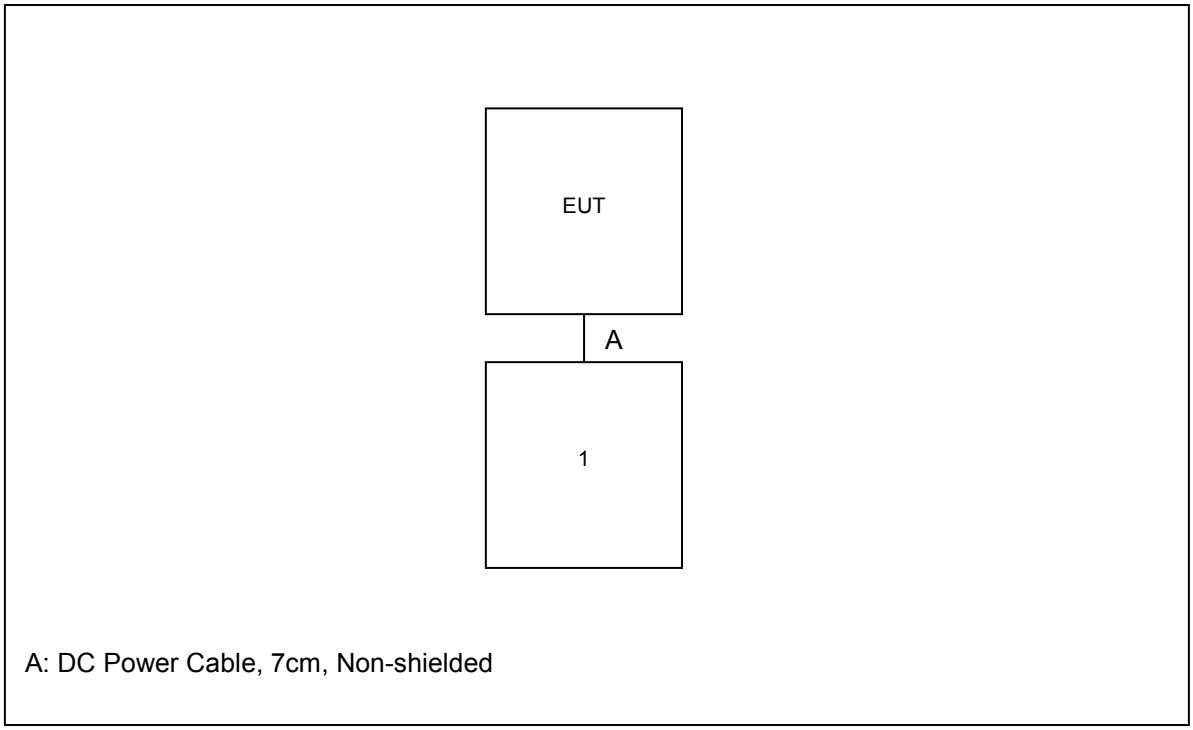

Figure 6-1: Test Setup Block Diagram

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 integral antenna is an Inverted F with 2dBi gain and cannot be removed without permanently damaging the device, therefore satisfying the requirements of Section 15.203.

7.2 Power Line Conducted Emissions – FCC 15.207

The EUT is a battery operated module; therefore, AC power line conducted emissions testing was not performed.

7.3 Peak Output Power - FCC 15.247(b)(2)

7.3.1 Measurement Procedure (Conducted Method)

The RF output port of the EUT was directly connected to the input of a power meter with suitable attenuation. The device employs >50 channels therefore the power is limited to 1 Watt.

All data rates were evaluated and worst case reported.

7.3.2 Measurement Results

Table 7.3.2-1: RF Output Power

Frequency [MHz]	Level [dBm]
902.3	24.60
915.0	24.47
927.9	24.26

7.4 Channel Usage Requirements

7.4.1 Carrier Frequency Separation – FCC 15.247(a)(1)

7.4.1.1 Measurement Procedure

The RF output port of the EUT was directly connected to the input of the spectrum analyzer with suitable attenuation. The span of the spectrum analyzer was set wide enough to capture two adjacent peaks and the RBW and VBW were set to ≥ 1% of the span.

Carrier frequency separation was measured for all modes of operation and data presented in section 7.4.1.2 below.

7.4.1.2 Measurement Results

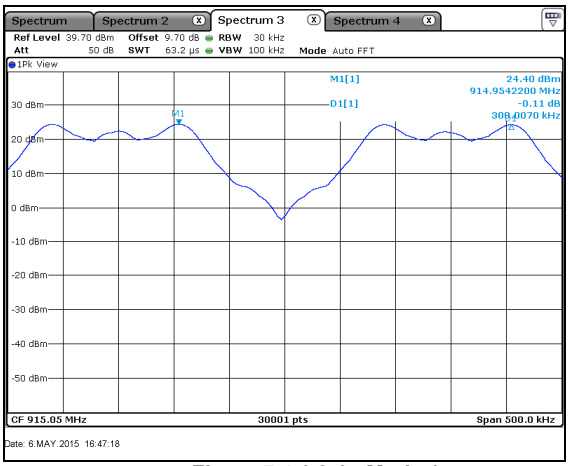

Figure 7.4.1.2-1: Mode 1

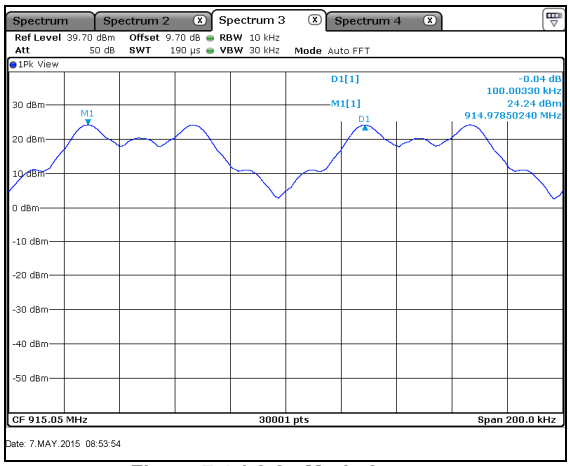

Figure 7.4.1.2-2: Mode 2

7.4.2 Number of Hopping Channels – FCC 15.247(a)(1)(i)

7.4.2.1 Measurement Procedure

The RF output port of the EUT was directly connected to the input of the spectrum analyzer with suitable attenuation. The span of the spectrum analyzer was set wide enough to capture the frequency band of operation. The RBW was set to ≥ 1% of the span and VBW set to ≥ RBW.

The number of hopping channels was measured for the modes of operation and data presented in section 7.4.2.2 below.

7.4.2.2 Measurement Results

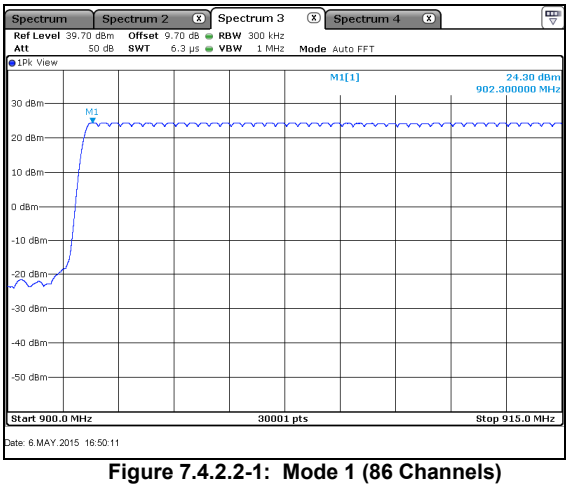

Figure 7.4.2.2-1: Mode 1 (86 Channels)

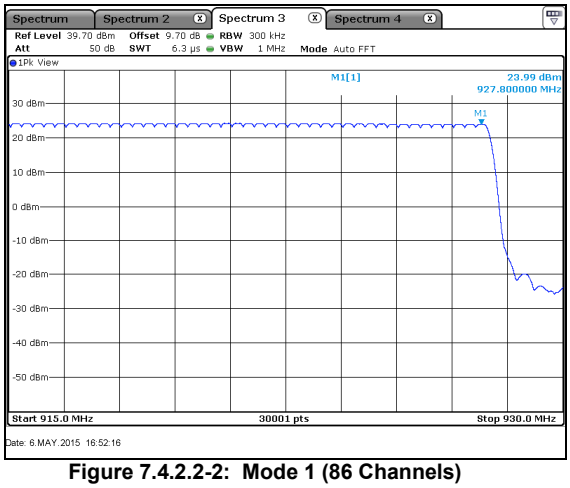

Figure 7.4.2.2-2: Mode 1 (86 Channels)

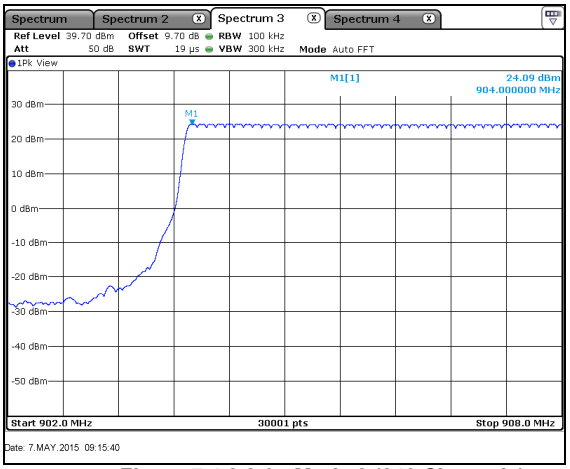

Figure 7.4.2.2-3: Mode 2 (240 Channels)

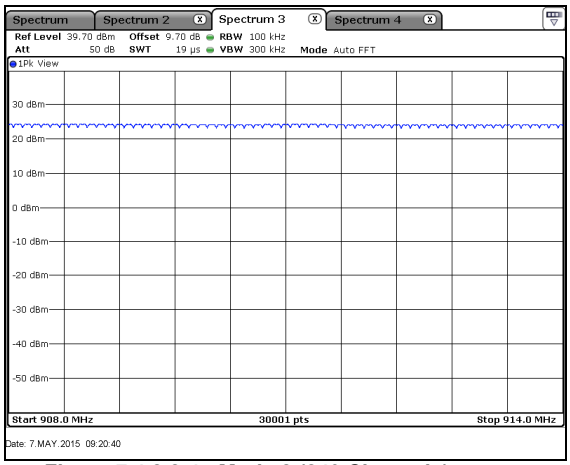

Figure 7.4.2.2-4: Mode 2 (240 Channels)

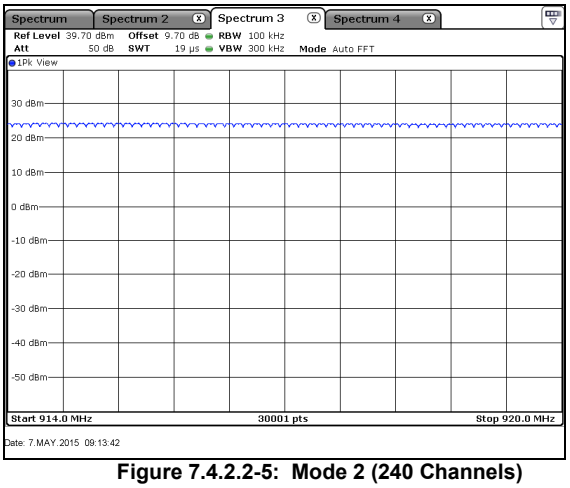

Figure 7.4.2.2-5: Mode 2 (240 Channels)

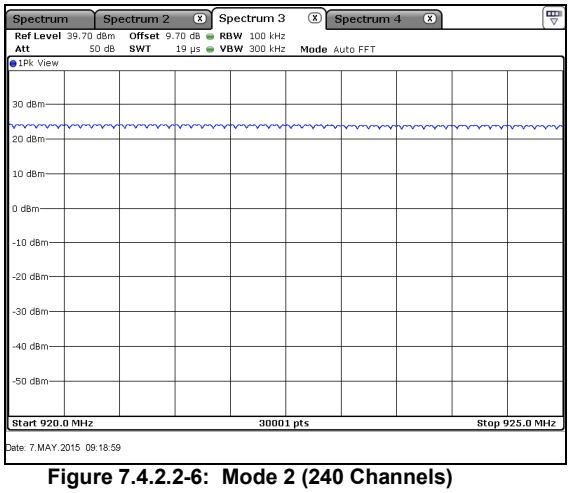

Figure 7.4.2.2-6: Mode 2 (240 Channels)

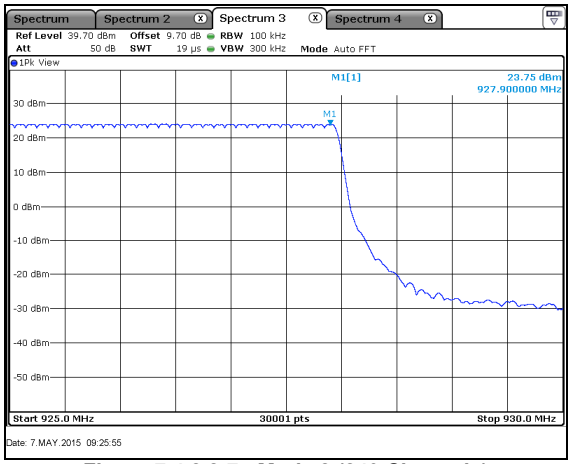

Figure 7.4.2.2-7: Mode 2 (240 Channels)

7.4.3 Channel Dwell Time – FCC 15.247(a)(1)(i)

7.4.3.1 Measurement Procedure

The EUT test mode does not generate a worst case channel dwell time therefore a detailed engineering analysis is provided in the theory of operation.

As described in the theory of operation, the maximum channel transmitter dwell time is ≤ 400ms per channel hop with the minimum period of 700ms between hops. Therefore the maximum time of occupancy on any one channel within a 20s period is ≤ 400ms for all modes of operation.

7.4.4 20dB Bandwidth - FCC 15.247(a)(1)(i)

7.4.4.1 Measurement Procedure

The RF output port of the EUT was directly connected to the input of the spectrum analyzer with suitable attenuation. The span of the spectrum analyzer display was set between two times and five times the occupied bandwidth (OBW) of the emission. The RBW of the spectrum analyzer was set to approximately 1 % to 5 % of the OBW. The trace was set to max hold with a peak detector active. The Delta and ndB down functions of the analyzer were utilized to determine the 20 dB bandwidth of the emission.

7.4.4.2 Measurement Results

Table 7.4.4.2-1: 20dB Bandwidth

Frequency [MHz]	20dB Bandwidth [kHz]	Data Rate (kbps)	Mode(s)
902.3	21.63	9.6	1 / 2
902.3	43.90	19.2	1 / 2
902.3	89.46	38.4	1 / 2
902.3	235.19	115.2	1
915.0	21.66	9.6	1 / 2
915.0	43.68	19.2	1 / 2
915.0	90.04	38.4	1 / 2
915.0	234.13	115.2	1
927.9	21.75	9.6	1 / 2
927.9	43.82	19.2	1 / 2
927.9	89.25	38.4	1 / 2
927.8	234.99	115.2	1

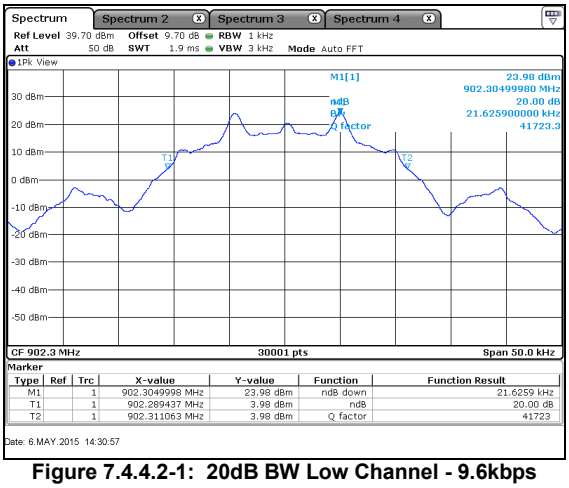

Figure 7.4.4.2-1: 20dB BW Low Channel - 9.6kbps

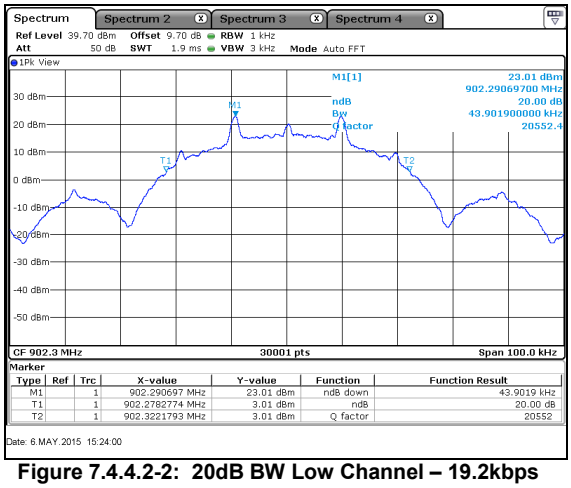

Figure 7.4.4.2-2: 20dB BW Low Channel – 19.2kbps

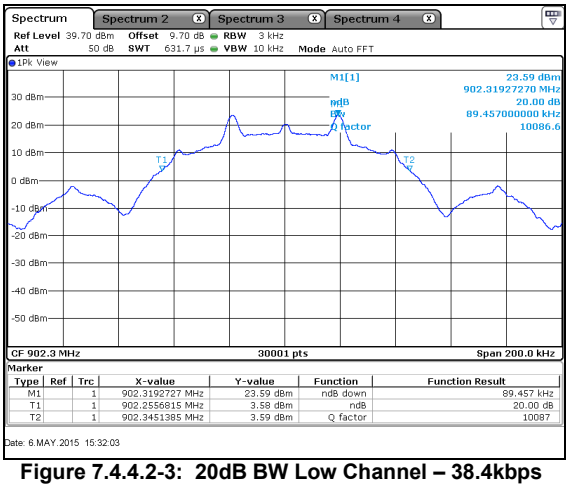

Figure 7.4.4.2-3: 20dB BW Low Channel – 38.4kbps

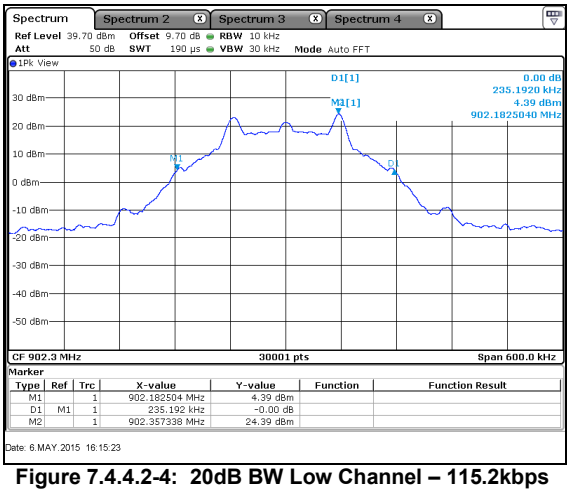

Figure 7.4.4.2-4: 20dB BW Low Channel – 115.2kbps

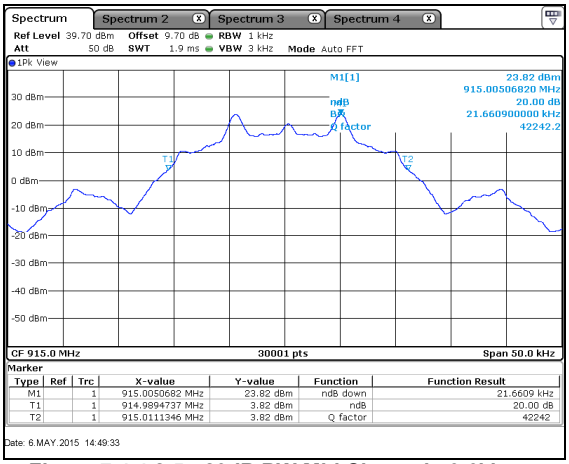

Figure 7.4.4.2-5: 20dB BW Mid Channel - 9.6kbps

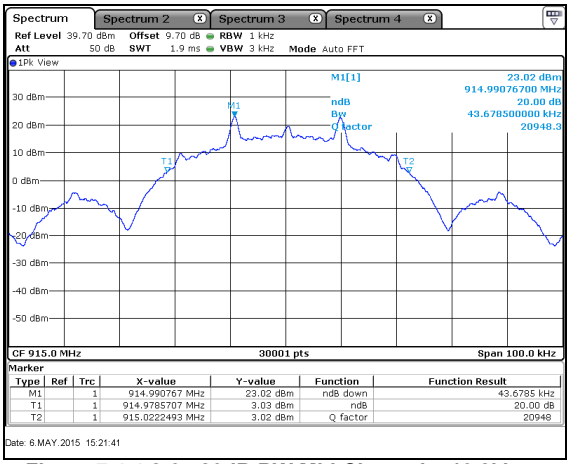

Figure 7.4.4.2-6: 20dB BW Mid Channel – 19.2kbps

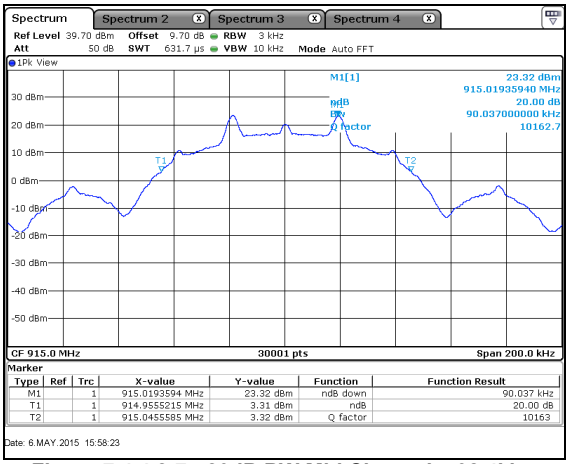

Figure 7.4.4.2-7: 20dB BW Mid Channel – 38.4kbps

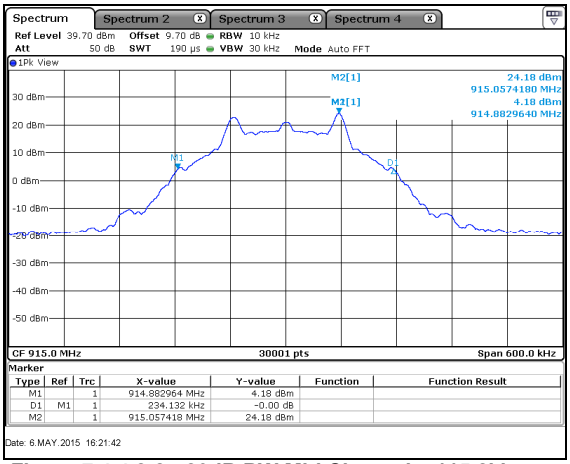

Figure 7.4.4.2-8: 20dB BW Mid Channel – 115.2kbps

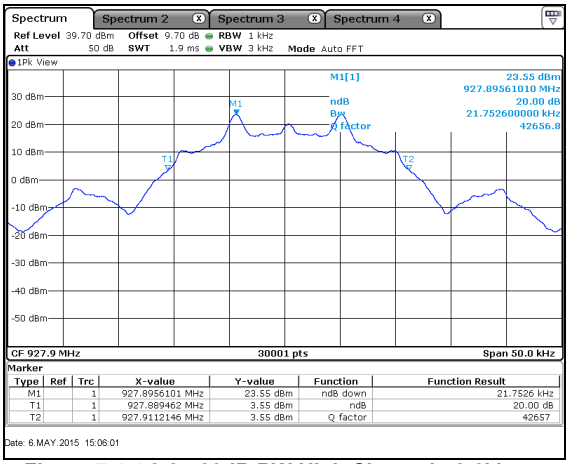

Figure 7.4.4.2-9: 20dB BW High Channel - 9.6kbps

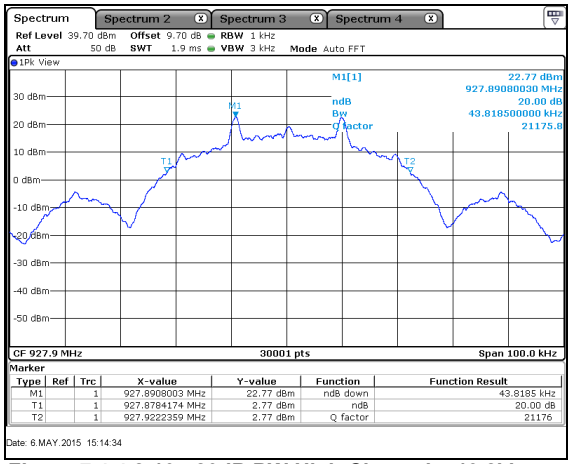

Figure 7.4.4.2-10: 20dB BW High Channel – 19.2kbps

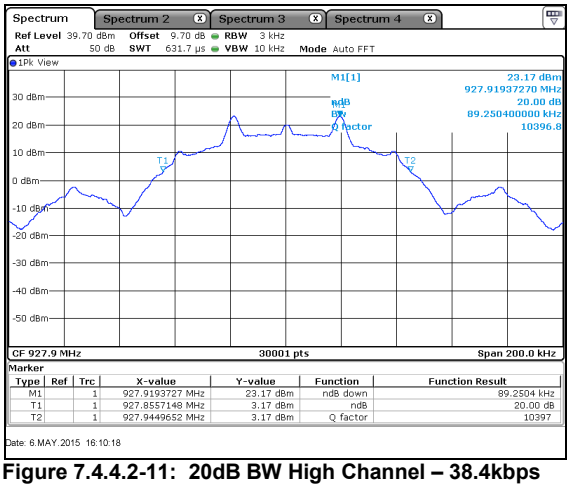

Figure 7.4.4.2-11: 20dB BW High Channel – 38.4kbps

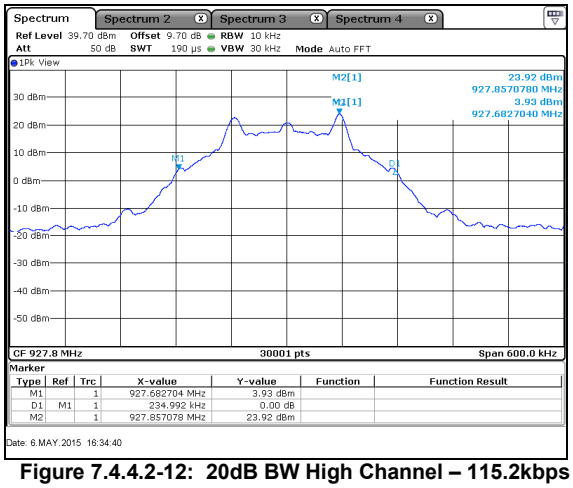

Figure 7.4.4.2-12: 20dB BW High Channel – 115.2kbps

7.5 Band-Edge Compliance and Spurious Emissions

7.5.1 Band-Edge Compliance of RF Conducted Emissions - FCC 15.247(d)

7.5.1.1 Measurement Procedure

The RF output port of the EUT was directly connected to the input of the spectrum analyzer with 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 ≥ 1% of the span, and the VBW was set to >> RBW.

Band-edge was evaluated for all combinations of operating modes and data rates. Worst case reported utilized 115.2kbps in Mode 1 and 38.4kbps in Mode 2

7.5.1.2 Measurement Results

NON-HOPPING MODE:

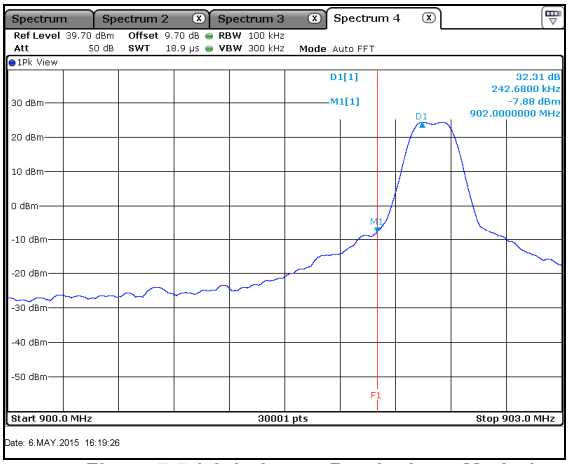

Figure 7.5.1.2-1: Lower Band-edge – Mode 1

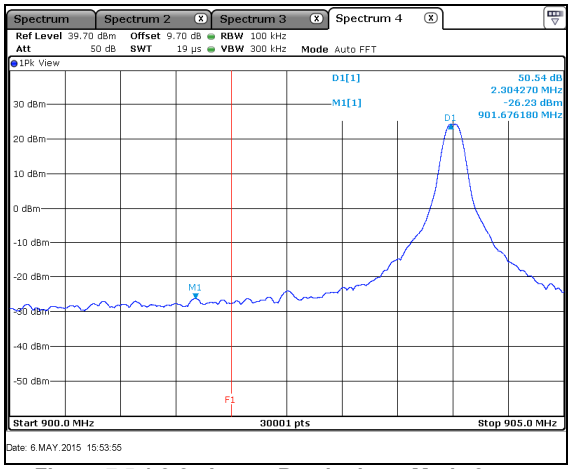

Figure 7.5.1.2-2: Lower Band-edge – Mode 2

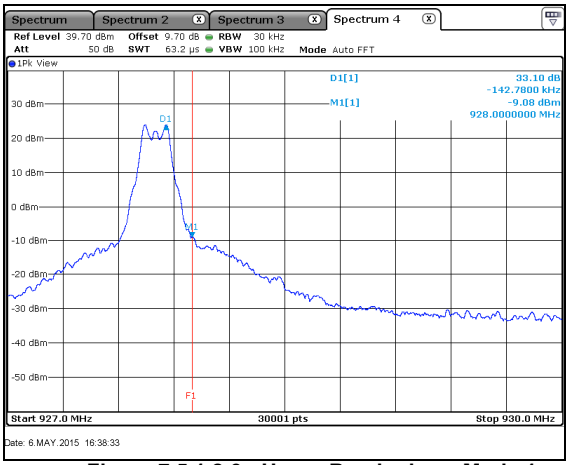

Figure 7.5.1.2-3: Upper Band-edge – Mode 1

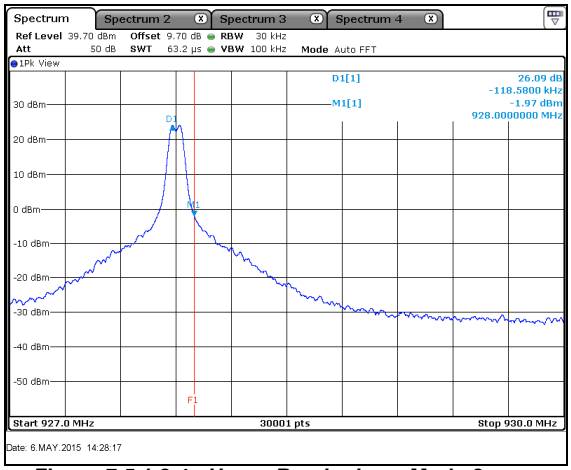

Figure 7.5.1.2-4: Upper Band-edge – Mode 2

HOPPING MODE:

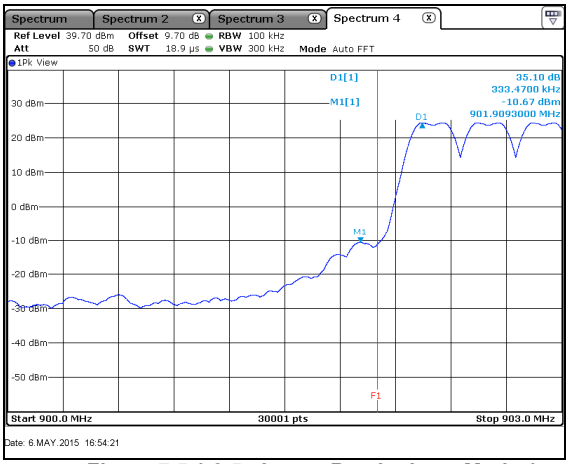

Figure 7.5.1.2-5: Lower Band-edge – Mode 1

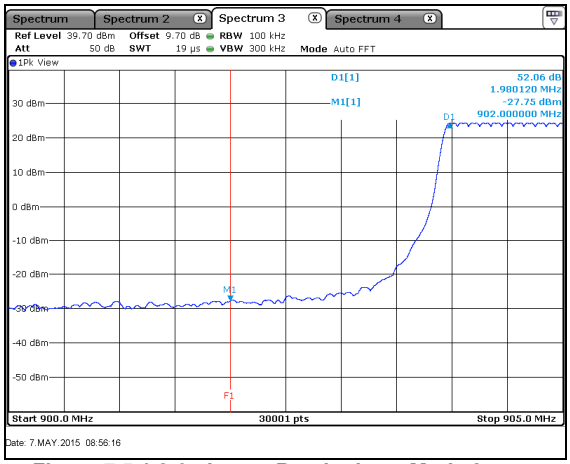

Figure 7.5.1.2-6: Lower Band-edge – Mode 2

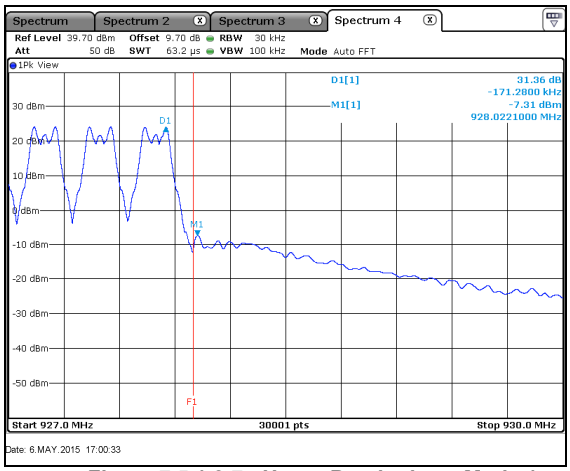

Figure 7.5.1.2-7: Upper Band-edge – Mode 1

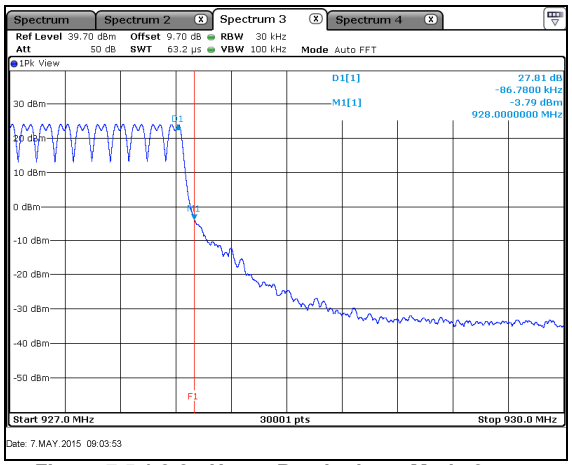

Figure 7.5.1.2-8: Upper Band-edge – Mode 2

7.5.2 RF Conducted Spurious Emissions - FCC 15.247(d)

7.5.2.1 Measurement Procedure

The RF output port of the EUT was directly connected to the input of the spectrum analyzer with suitable attenuation. The EUT was investigated for conducted spurious emissions from 30MHz to 10GHz, 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 100kHz. A peak detector function was used with the trace set to max hold.

RF conducted spurious emissions were evaluated for all combinations of operating modes and data rates with worst case data provided.

7.5.2.2 Measurement Results

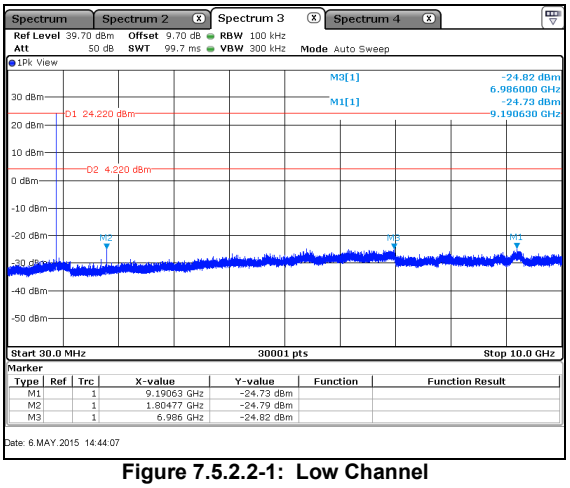

Figure 7.5.2.2-1: Low Channel

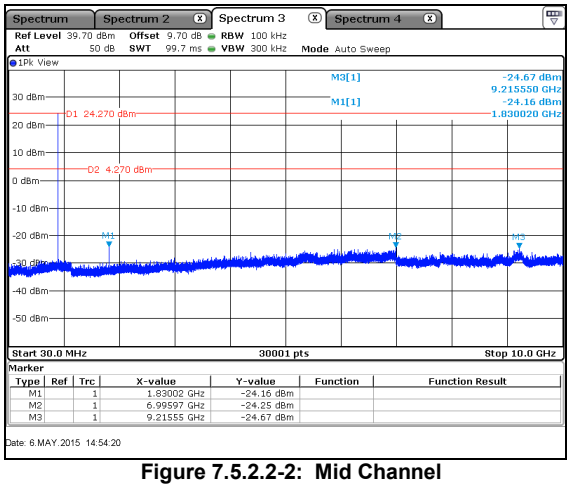

Figure 7.5.2.2-2: Mid Channel

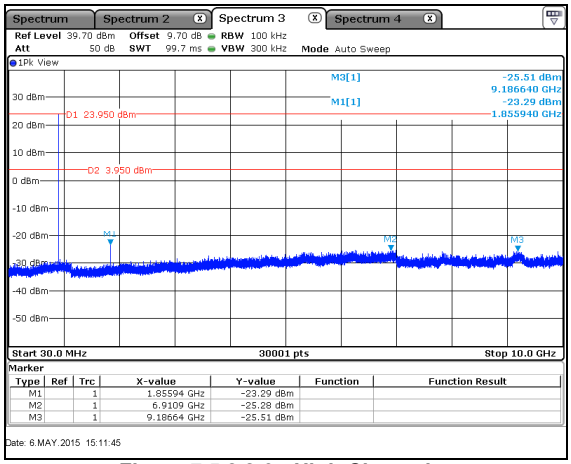

Figure 7.5.2.2-3: High Channel

7.5.3 Radiated Spurious Emissions - FCC 15.205, 15.209

7.5.3.1 Measurement Procedure

Radiated emissions tests were made over the frequency range of 30MHz to 10GHz, 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 were made with RBW and VBW of 1 MHz and 3MHz respectively.

The EUT was caused to generate a continuous modulated carrier on the hopping channel.

Each emission found to be in a restricted band was compared to the applicable radiated emission limits.

Radiated spurious emissions were evaluated for all combinations of operating modes and data rates with worst case data provided.

7.5.3.2 Measurement Results

Table 7.5.3.2-1: 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										
960.11	---------	41.18	H	1.99	---------	43.17	--------	54.0	---------	10.8
960.11	---------	37.30	V	1.99	---------	39.29	--------	54.0	---------	14.7
1011	62.71	51.13	H	-13.94	48.77	37.19	74.0	54.0	25.2	16.8
1011	63.53	51.69	V	-13.94	49.59	37.75	74.0	54.0	24.4	16.3
Middle Channel										
1011	64.94	53.01	H	-13.94	51.00	39.07	74.0	54.0	23.0	14.9
1011	64.41	52.71	V	-13.94	50.47	38.77	74.0	54.0	23.5	15.2
High Channel										
1009	65.23	53.21	H	-13.95	51.28	39.26	74.0	54.0	22.7	14.7
1009	65.12	53.82	V	-13.95	51.17	39.87	74.0	54.0	22.8	14.1

7.5.3.3 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

Example Calculation: Peak

Corrected Level: 62.71 - 13.94 = 48.77dBuV/m
Margin: 74dBuV/m – 48.77dBuV/m = 25.2dB

Example Calculation: Average

Corrected Level: 51.13 - 13.94 - 0 = 37.19dBuV
Margin: 54dBuV – 37.19dBuV = 16.8dB

8 CONCLUSION

In the opinion of ACS, Inc. the M120, manufactured by Landis+Gyr Technology, Inc. meets the requirements of FCC Part 15 subpart C.

END REPORT