Excellence in Compliance Testing

# Certification Test Report

**FCC ID: QZC-REXUA**
**IC: 4557A-REXUA**

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

**ACS Report Number: 15-0285.W06.1A**

Manufacturer: Elster Solutions, LLC
Model: REXUA

Test Begin Date: July 24, 2015
Test End Date: July 29, 2015

Report Issue Date: August 24, 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 38 pages**

# TABLE OF CONTENTS


**1 GENERAL ..... 3**

1.1 PURPOSE ..... 3
1.2 PRODUCT DESCRIPTION ..... 3
1.3 TEST METHODOLOGY AND CONSIDERATIONS ..... 4

**2 TEST FACILITIES ..... 5**

2.1 LOCATION ..... 5
2.2 LABORATORY ACCREDITATIONS/RECOGNITIONS/CERTIFICATIONS ..... 5
2.3 RADIATED EMISSIONS TEST SITE DESCRIPTION ..... 6
*2.3.1 Semi-Anechoic Chamber Test Site ..... 6*
*2.3.2 Open Area Tests Site (OATS) ..... 7*
2.4 CONDUCTED EMISSIONS TEST SITE DESCRIPTION ..... 8

**3 APPLICABLE STANDARD REFERENCES ..... 8**

**4 LIST OF TEST EQUIPMENT ..... 9**

**5 SUPPORT EQUIPMENT ..... 10**

**6 EQUIPMENT UNDER TEST SETUP BLOCK DIAGRAM ..... 10**

**7 SUMMARY OF TESTS ..... 11**

7.1 ANTENNA REQUIREMENT – FCC: SECTION 15.203 ..... 11
7.2 POWER LINE CONDUCTED EMISSIONS – FCC 15.207, IC: RSS-GEN 8.8 ..... 11
*7.2.1 Measurement Procedure ..... 11*
*7.2.2 Measurement Results ..... 11*
7.3 PEAK OUTPUT POWER - FCC 15.247(B)(2) IC: RSS-247 5.4(1) ..... 12
*7.3.1 Measurement Procedure (Conducted Method) ..... 12*
*7.3.2 Measurement Results ..... 12*
7.4 CHANNEL USAGE REQUIREMENTS ..... 16
*7.4.1 Carrier Frequency Separation – FCC 15.247(a)(1) IC: RSS-247 5.1(2) ..... 16*
7.4.1.1 Measurement Procedure ..... 16
7.4.1.2 Measurement Results ..... 16
*7.4.2 Number of Hopping Channels – FCC 15.247(a)(1)(i) IC: RSS-247 5.1(3) ..... 18*
7.4.2.1 Measurement Procedure ..... 18
7.4.2.2 Measurement Results ..... 18
*7.4.3 Channel Dwell Time – FCC 15.247(a)(1)(i) IC: RSS-247 5.1(3) ..... 20*
7.4.3.1 Measurement Procedure ..... 20
7.4.3.2 Measurement Results ..... 20
*7.4.4 20dB / 99% Bandwidth - FCC 15.247(a)(1)(i) IC: RSS-247 5.1(3) ..... 21*
7.4.4.1 Measurement Procedure ..... 21
7.4.4.2 Measurement Results ..... 21
7.5 BAND-EDGE COMPLIANCE AND SPURIOUS EMISSIONS ..... 27
*7.5.1 Band-Edge Compliance of RF Conducted Emissions - FCC 15.247(d); IC RSS-247 5.5 ..... 27*
7.5.1.1 Measurement Procedure ..... 27
7.5.1.2 Measurement Results ..... 27
*7.5.2 RF Conducted Spurious Emissions - FCC 15.247(d); IC RSS-247 5.5 ..... 31*
7.5.2.1 Measurement Procedure ..... 31
7.5.2.2 Measurement Results ..... 31
*7.5.3 Radiated Spurious Emissions - FCC 15.205, 15.209; RSS-Gen 8.9/8.10 ..... 34*
7.5.3.1 Measurement Procedure ..... 34
7.5.3.2 Measurement Results ..... 34
7.5.3.3 Sample Calculation: ..... 35

**8 CONCLUSION ..... 36**

# 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 Certification for modular approval.

## 1.2 Product description

The REXUA module contains (1) 900MHz frequency hopping spread spectrum radio and (1) 2.4GHz direct sequence spread spectrum Zigbee radio. This report addresses the 900MHz frequency hopping spread spectrum radio only. The REXUA forms a complete electricity meter when installed in a housing and meter base. The REXUA module utilizes two distinct modes of operation; Energy Axis (EA) networking architecture devised by Elster Electricity LLC at low power, and Smart Metering Utility Network (SUN) networking architecture at high power.

Technical Details:

| Mode of Operation | Frequency Range (MHz) | Number of Channels | Data Rates Supported (kbps) |
|---|---|---|---|
| 1 | 902.4 - 927.6 | 25 | 35.5, 142.2 |
| 2 | 902.4 - 927.6 | 64 | 50, 150, 200 |

Modulation Format: FSK/GFSK
Antenna Type / Gain: Printed circuit open-end slot antenna / 4.1dBi
Operating Voltage: 18Vdc

Manufacturer Information:
Elster Solutions, LLC
208 South Rogers Lane
Raleigh, NC 27610

EUT Serial Numbers: 5D26119G1403 1 1152400182

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 for each mode. 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 the Y-orientation.

For AC power line conducted emissions the EUT was evaluated with a typical host in the high power mode.

The EUT utilizes 25 hopping channels in the range from 902.4 MHz to 927.6 MHz using multiple hopping tables. Data was collected using multiple hopping tables to show compliance for all possible operating conditions (i.e. hopping band-edge at extreme operating band-edges).

Radiated inter-modulation testing was performed for all combinations of simultaneous transmission and found to be in compliance.

Software power settings during test for mode 1: 44 (Low Channel), 38 (Mid Channel), 34 (High Channel)
Software power setting during test for mode 2: 38 (Low Channel), 36 (Mid Channel), 34 (High Channel)

# 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:

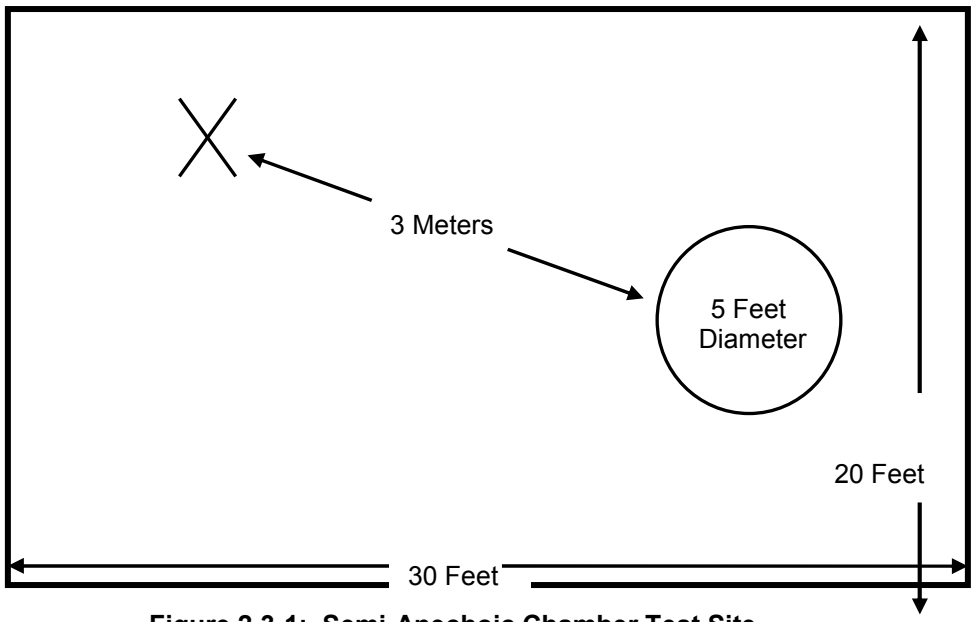


**Figure 2.3-1: Semi-Anechoic Chamber Test Site**

### 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:

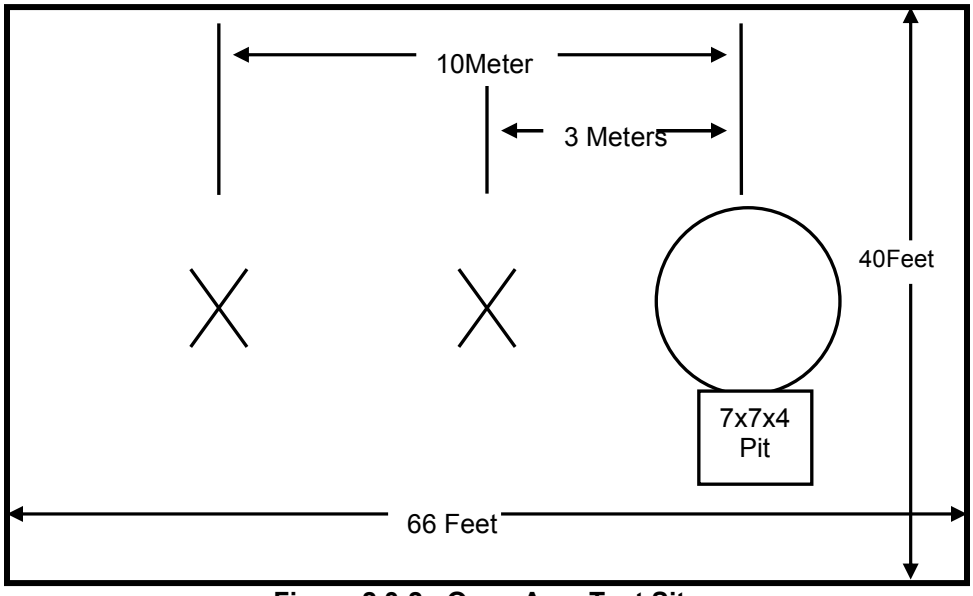


**Figure 2.3-2: Open Area Test Site**

## 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:

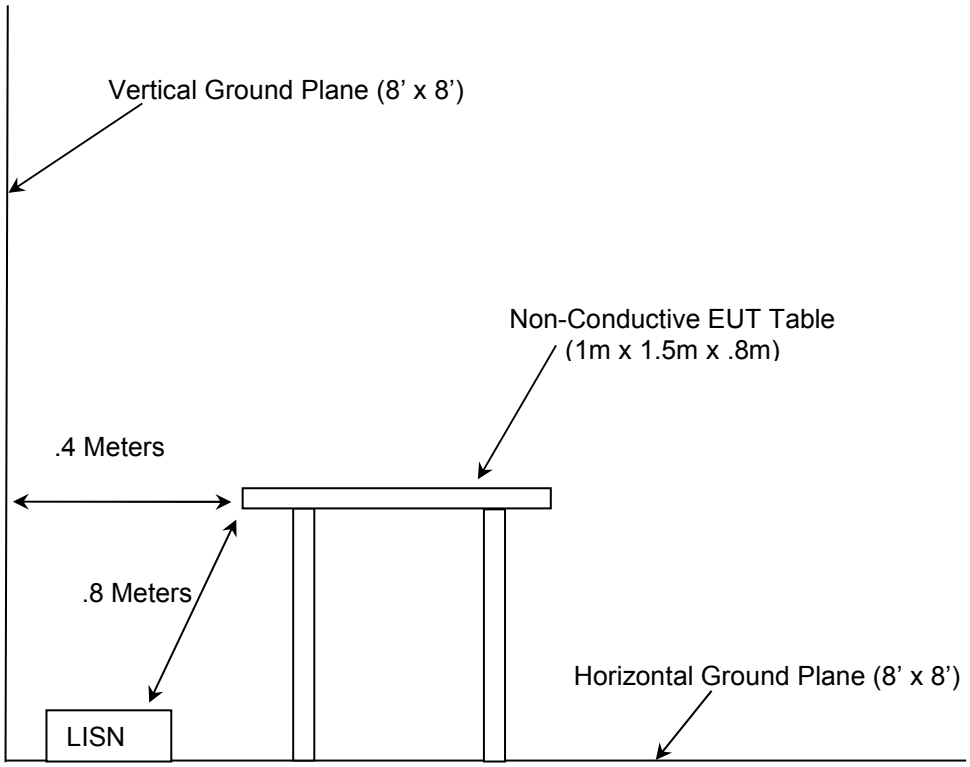


**Figure 2.4-1: AC Mains Conducted EMI Site**

## 3 APPLICABLE STANDARD REFERENCES

The following standards were used:

- ANSI C63.10-2013: 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 and Information for the Certification of Radiocommunication Equipment, Issue 4, Nov 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 |
|---|---|---|---|---|---|---|
| 1 | Rohde & Schwarz | ESMI - Display | Spectrum Analyzers | 833771/007 | 7/14/2015 | 7/14/2016 |
| 2 | Rohde & Schwarz | ESMI-Receiver | Spectrum Analyzers | 839587/003 | 7/14/2015 | 7/14/2016 |
| 30 | Spectrum Technologies | DRH-0118 | Antennas | 970102 | 4/30/2015 | 4/30/2017 |
| 40 | EMCO | 3104 | Antennas | 3211 | 2/10/2015 | 2/10/2017 |
| 73 | Agilent | 8447D | Amplifiers | 2727A05624 | 7/15/2015 | 7/15/2016 |
| 167 | ACS | Chamber EMI Cable Set | Cable Set | 167 | 10/28/2014 | 10/28/2015 |
| 168 | Hewlett Packard | 11947A | Attenuators | 44829 | 1/19/2015 | 1/19/2016 |
| 292 | Florida RF Cables | SMR-290AW-480.0-SMR | Cables | None | 3/3/2015 | 3/3/2016 |
| 316 | Rohde Schwarz | ESH3-Z5 | LISN | 861189-010 | 7/14/2015 | 7/14/2016 |
| 324 | ACS | Belden | Cables | 8214 | 5/5/2015 | 5/5/2016 |
| 337 | Microwave Circuits | H1G513G1 | Filters | 282706 | 5/20/2015 | 5/20/2016 |
| 338 | Hewlett Packard | 8449B | Amplifiers | 3008A01111 | 7/30/2013 | 8/30/2015 |
| 340 | Aeroflex/Weinschel | AS-20 | Attenuators | 7136 | 7/13/2015 | 7/13/2016 |
| 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 | 7/15/2015 | 7/15/2016 |
| RE112 | Rohde & Schwarz | ESIB26 | Receiver | 836119/012 | 7/16/2015 | 7/16/2016 |

## 5 SUPPORT EQUIPMENT

**Table 5-1: Support Equipment**

| Item | Equipment Type | Manufacturer | Model Number | Serial Number |
|---|---|---|---|---|
| 1 | Signal/Power Adaptor PCB | Elster Solutions, LLC | N/A | N/A |
| 2 | AC Adaptor | CUI Inc. | EMSA180100 | N/A |
| 3 | DC Power Supply | Hewlett Packard | E3630A | KR64308603 |
| 4 | Electric Utility Meter | Elster Electricity, LLC. | FM2S | 18 935 643 |

## 6 EQUIPMENT UNDER TEST SETUP BLOCK DIAGRAM

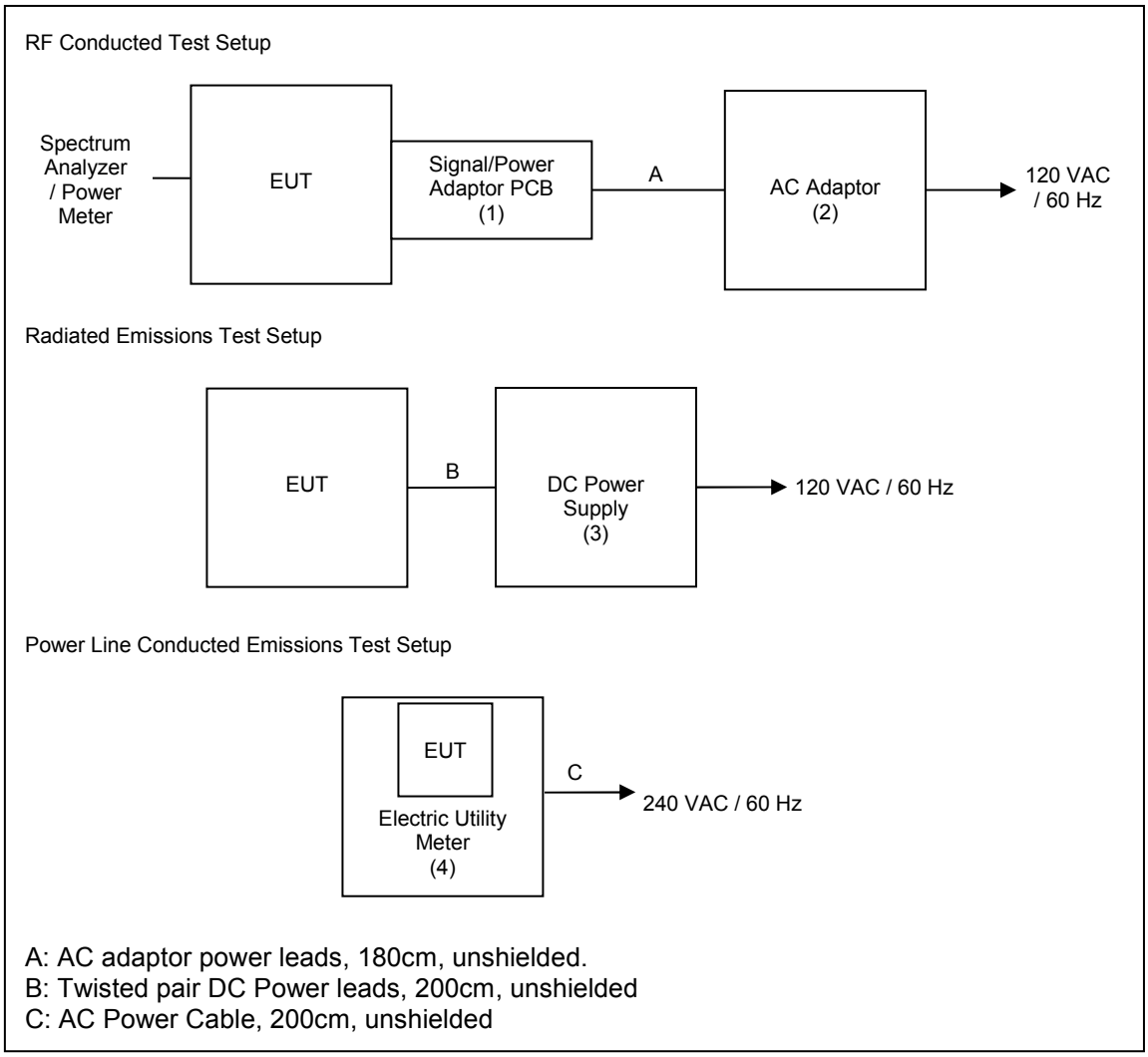


**Figure 6-1: Test Setup Block Diagram**

# 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 EUT utilizes a printed circuit open-end slot antenna therefore satisfying the requirements of Section 15.203.

## 7.2 Power Line Conducted Emissions – FCC 15.207, IC: RSS-Gen 8.8

### 7.2.1 Measurement Procedure

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

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

### 7.2.2 Measurement Results

**Table 7.2.2-1: Conducted EMI Results Line 1**

| Frequency (MHz) | QuasiPeak (dBµV) | Average (dBµV) | Limit (dBµV) | Margin (dB) | Line | Corr. (dB) |
|---|---|---|---|---|---|---|
| 0.154628 | --- | 35.24 | 55.72 | 20.48 | L1 | 10.1 |
| 0.154628 | 48.84 | --- | 65.73 | 16.89 | L1 | 10.1 |
| 0.171461 | --- | 32.22 | 54.79 | 22.57 | L1 | 10.1 |
| 0.171461 | 46.24 | --- | 64.81 | 18.57 | L1 | 10.1 |
| 0.271343 | --- | 28.19 | 50.83 | 22.64 | L1 | 10.1 |
| 0.271343 | 42.34 | --- | 60.87 | 18.53 | L1 | 10.1 |
| 0.320541 | --- | 26.47 | 49.47 | 23.00 | L1 | 10.1 |
| 0.320541 | 39.08 | --- | 59.50 | 20.42 | L1 | 10.1 |
| 0.323748 | --- | 26.50 | 49.39 | 22.89 | L1 | 10.1 |
| 0.323748 | 39.12 | --- | 59.42 | 20.30 | L1 | 10.1 |
| 0.713928 | --- | 25.20 | 46.00 | 20.80 | L1 | 10.1 |
| 0.713928 | 33.53 | --- | 56.00 | 22.47 | L1 | 10.1 |

**Table 7.2.2-2: Conducted EMI Results Line 2**

| Frequency (MHz) | QuasiPeak (dBµV) | Average (dBµV) | Limit (dBµV) | Margin (dB) | Line | Corr. (dB) |
|---|---|---|---|---|---|---|
| 0.238778 | --- | 31.27 | 51.90 | 20.63 | N | 10.1 |
| 0.238778 | 44.11 | --- | 61.94 | 17.83 | N | 10.1 |
| 0.273447 | --- | 28.23 | 50.77 | 22.54 | N | 10.1 |
| 0.273447 | 42.15 | --- | 60.81 | 18.66 | N | 10.1 |
| 0.283968 | --- | 27.42 | 50.45 | 23.03 | N | 10.1 |
| 0.283968 | 40.33 | --- | 60.49 | 20.16 | N | 10.1 |
| 0.681362 | --- | 23.78 | 46.00 | 22.22 | N | 10.1 |
| 0.681362 | 33.47 | --- | 56.00 | 22.53 | N | 10.1 |
| 0.693387 | --- | 24.91 | 46.00 | 21.09 | N | 10.1 |
| 0.693387 | 33.67 | --- | 56.00 | 22.33 | N | 10.1 |
| 0.714128 | --- | 25.20 | 46.00 | 20.80 | N | 10.1 |
| 0.714128 | 33.39 | --- | 56.00 | 22.61 | N | 10.1 |

## 7.3 Peak Output Power - FCC 15.247(b)(2) IC: RSS-247 5.4(1)

### 7.3.1 Measurement Procedure (Conducted Method)

The RF output port of the EUT was directly connected to the input of a spectrum analyzer using suitable attenuation. The device employs < 50 channels at any given time in Mode 1 therefore the power is limited to 0.25 Watt. The device employs > 50 channels at any given time in Mode 2 therefore the power is limited to 1 Watt.

### 7.3.2 Measurement Results

**Table 7.3.2-1: Maximum Conducted Peak Output Power**

| Frequency [MHz] | Level [dBm] | Data Rate [kbps] |
|---|---|---|
| 902.4 | 23.69 | 35.5 |
| 902.4 | 23.71 | 142.2 |
| 902.4 | 29.30 | 50 |
| 902.4 | 29.30 | 150 |
| 902.4 | 29.29 | 200 |
| 916.0 | 23.67 | 35.5 |
| 916.0 | 23.70 | 142.2 |
| 916.0 | 29.29 | 50 |
| 916.0 | 29.30 | 150 |
| 916.0 | 29.29 | 200 |
| 927.6 | 23.67 | 35.5 |
| 927.6 | 23.72 | 142.2 |
| 927.6 | 29.29 | 50 |
| 927.6 | 29.29 | 150 |
| 927.6 | 29.29 | 200 |

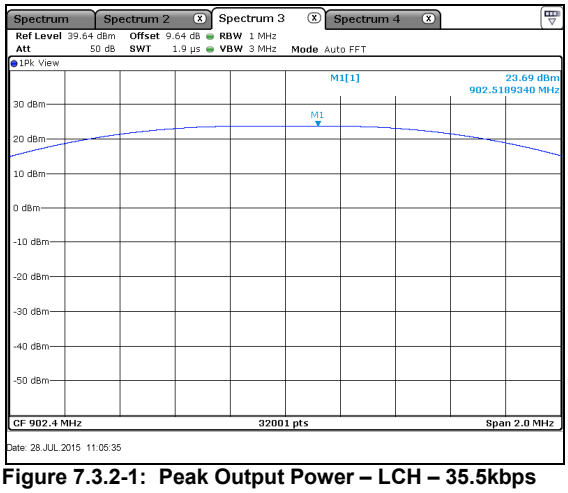


**Figure 7.3.2-1: Peak Output Power – LCH – 35.5kbps**

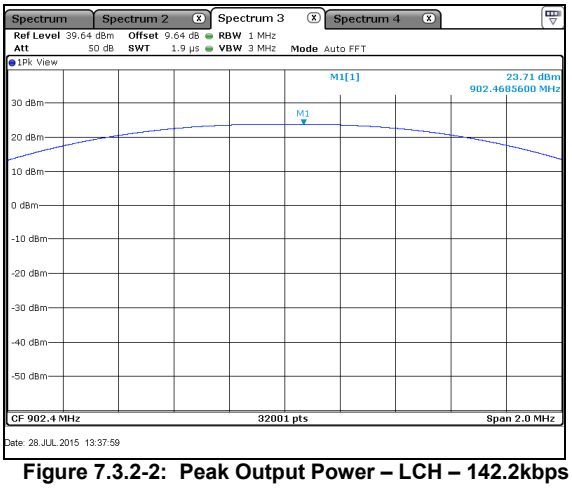


**Figure 7.3.2-2: Peak Output Power – LCH – 142.2kbps**

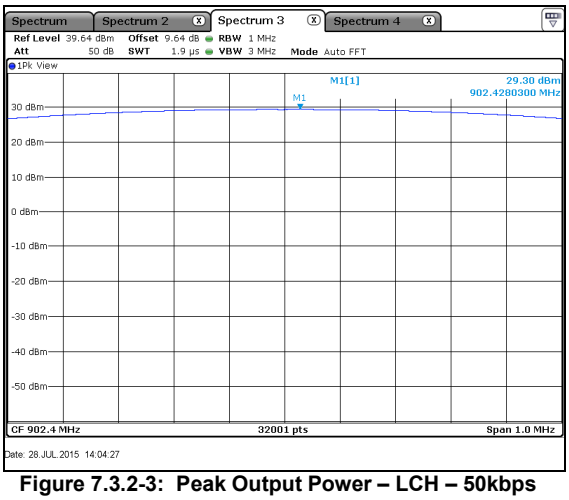


Figure 7.3.2-3: Peak Output Power – LCH – 50kbps

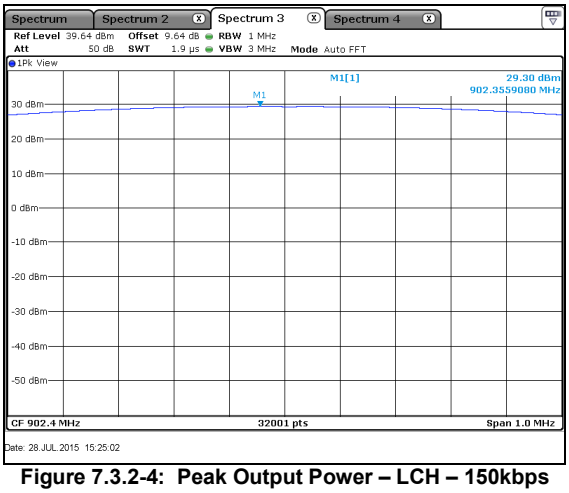


Figure 7.3.2-4: Peak Output Power – LCH – 150kbps

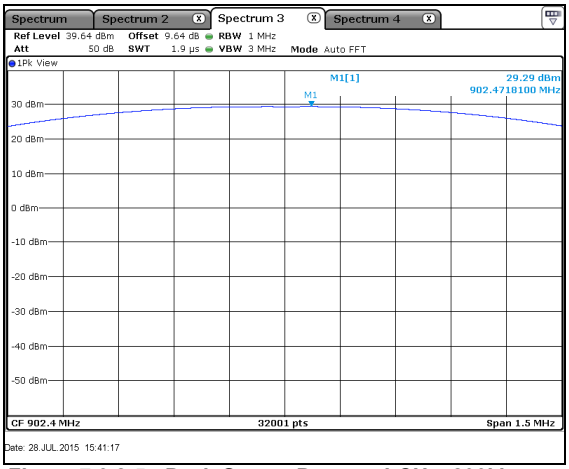


Figure 7.3.2-5: Peak Output Power – LCH – 200kbps

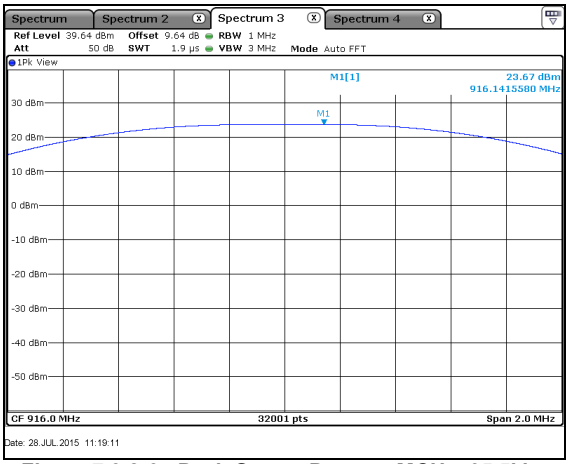


Figure 7.3.2-6: Peak Output Power – MCH – 35.5kbps

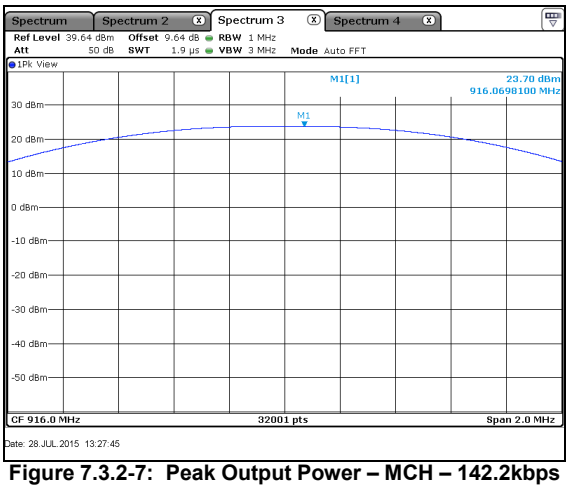


Figure 7.3.2-7: Peak Output Power – MCH – 142.2kbps

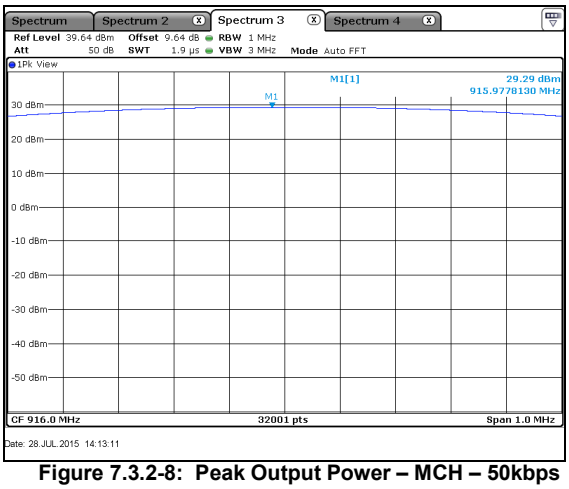


Figure 7.3.2-8: Peak Output Power – MCH – 50kbps

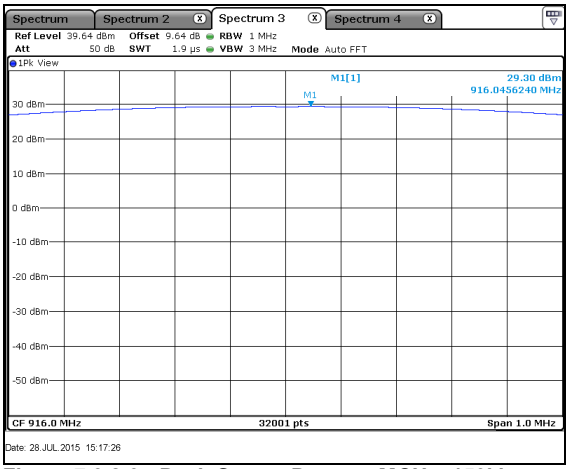


Figure 7.3.2-9: Peak Output Power – MCH – 150kbps

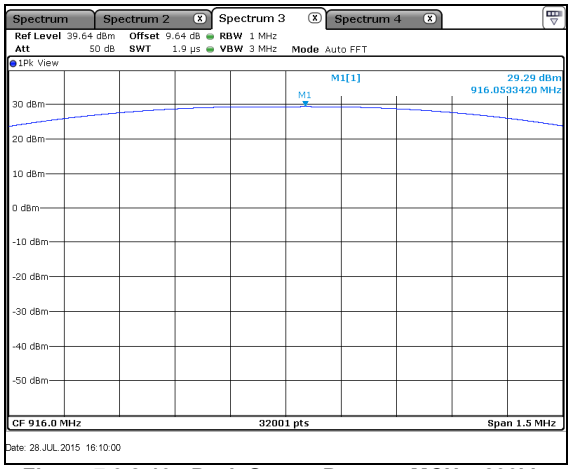


Figure 7.3.2-10: Peak Output Power – MCH – 200kbps

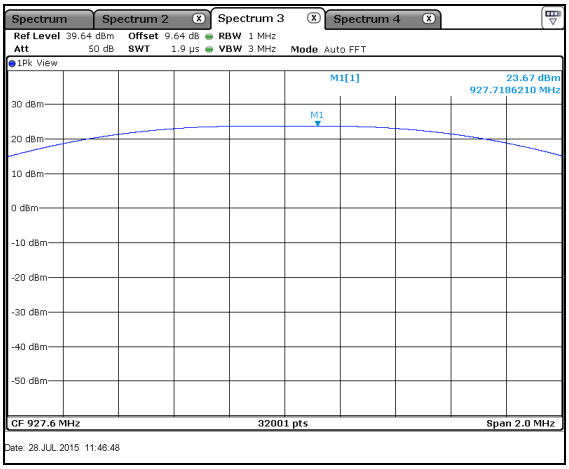


Figure 7.3.2-11: Peak Output Power – HCH – 35.5kbps

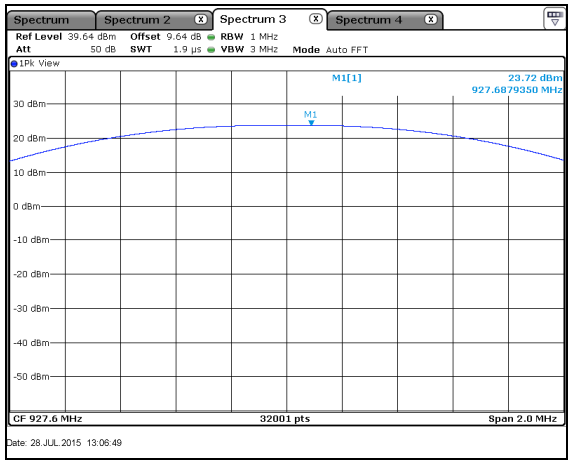


Figure 7.3.2-12: Peak Output Power – HCH – 142.2kbps

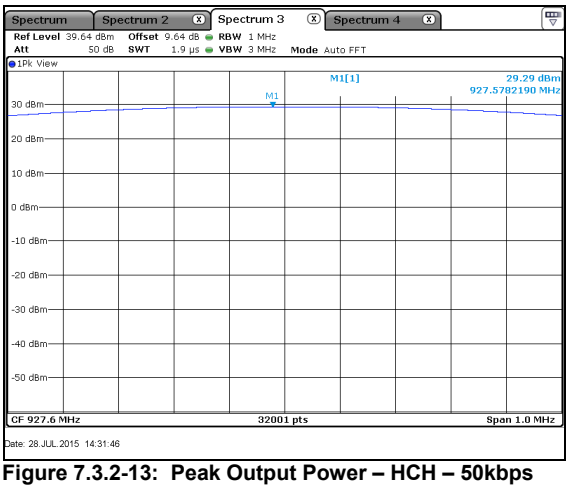


Figure 7.3.2-13: Peak Output Power – HCH – 50kbps

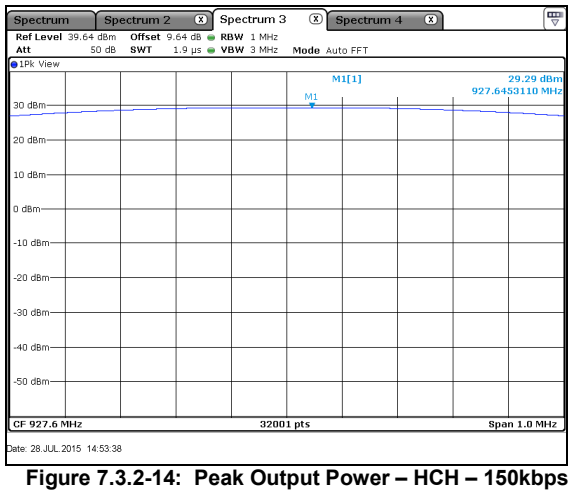


Figure 7.3.2-14: Peak Output Power – HCH – 150kbps

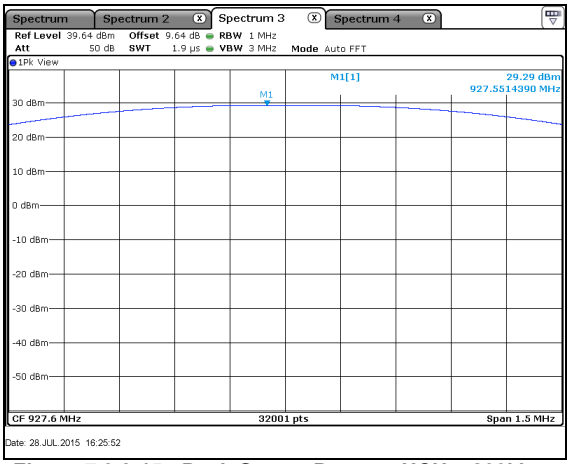


**Figure 7.3.2-15: Peak Output Power – HCH – 200kbps**

## 7.4 Channel Usage Requirements

### 7.4.1 Carrier Frequency Separation – FCC 15.247(a)(1) IC: RSS-247 5.1(2)

#### 7.4.1.1 Measurement Procedure

The RF output port of the EUT was directly connected to the input of the spectrum analyzer using suitable attenuation. The span of the spectrum analyzer was set wide enough to capture two adjacent peaks. The RBW was set to approximately 30% of the channel spacing and adjusted as necessary to best identify the center of each channel. The VBW was set > RBW.

#### 7.4.1.2 Measurement Results

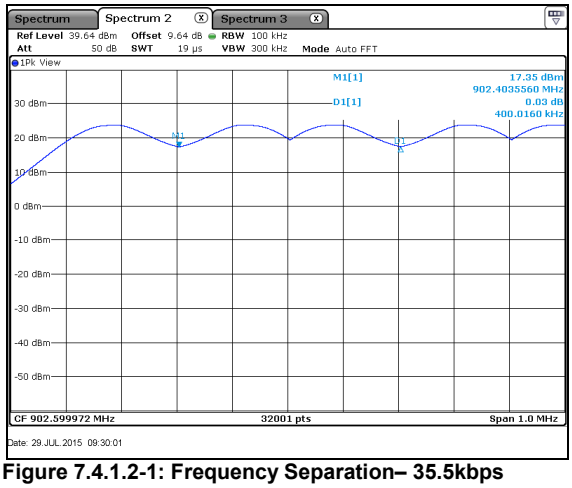


Figure 7.4.1.2-1: Frequency Separation– 35.5kbps

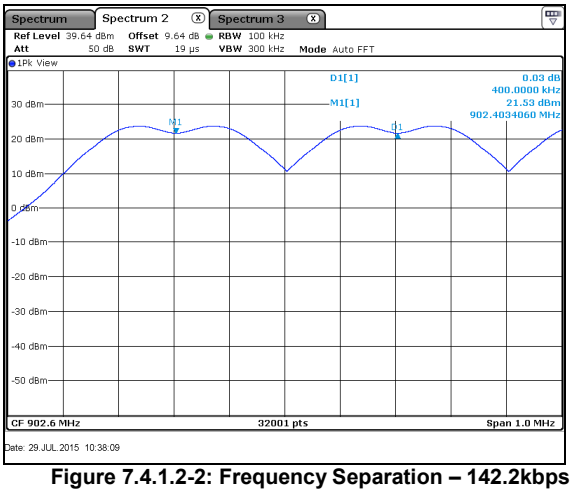


Figure 7.4.1.2-2: Frequency Separation – 142.2kbps

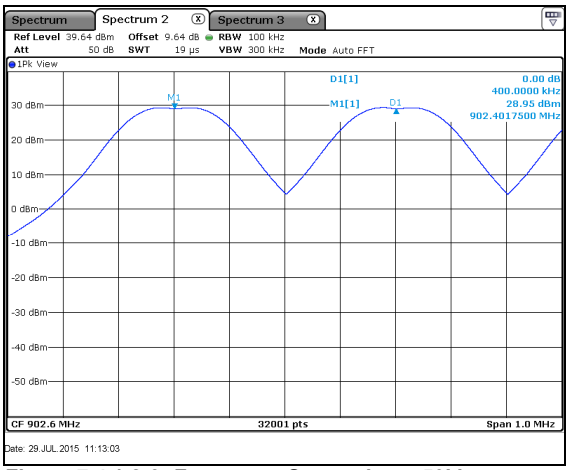


Figure 7.4.1.2-3: Frequency Separation – 50kbps

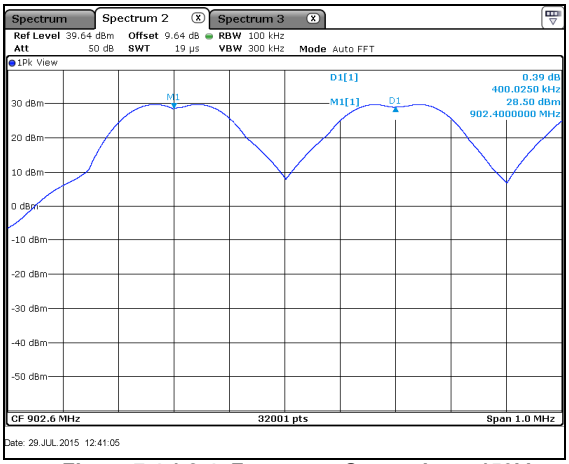


Figure 7.4.1.2-4: Frequency Separation – 150kbps

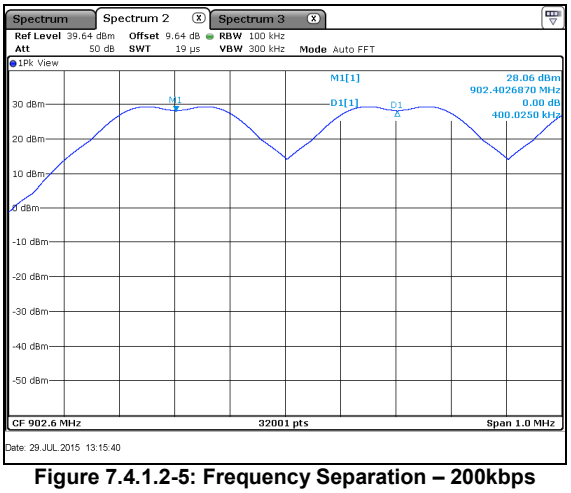


**Figure 7.4.1.2-5: Frequency Separation – 200kbps**

### 7.4.2 Number of Hopping Channels – FCC 15.247(a)(1)(i) IC: RSS-247 5.1(3)

#### 7.4.2.1 Measurement Procedure

The RF output port of the EUT was directly connected to the input of the spectrum analyzer using suitable attenuation. The span of the spectrum analyzer was set wide enough to capture the frequency band of operation. The RBW was set to < 30% of the channel spacing and VBW set to ≥ RBW.

#### 7.4.2.2 Measurement Results

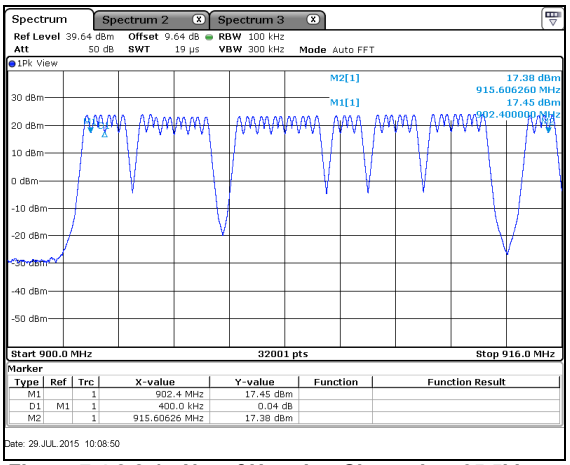


Figure 7.4.2.2-1: No. of Hopping Channels – 35.5kbps

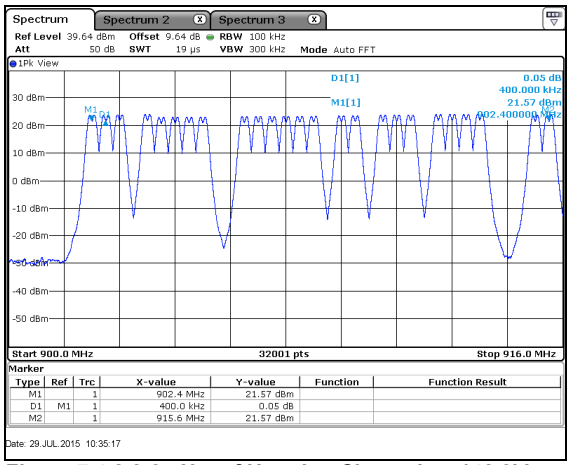


Figure 7.4.2.2-2: No. of Hopping Channels – 142.2kbps

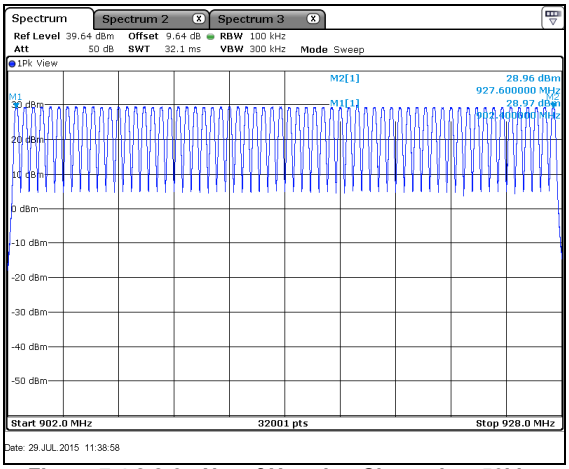


Figure 7.4.2.2-3: No. of Hopping Channels – 50kbps

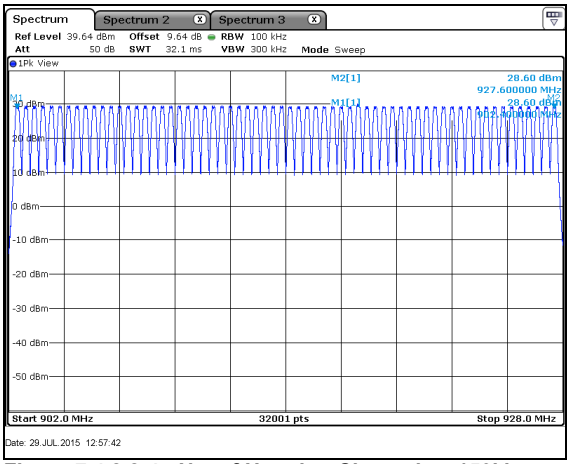


Figure 7.4.2.2-4: No. of Hopping Channels – 150kbps

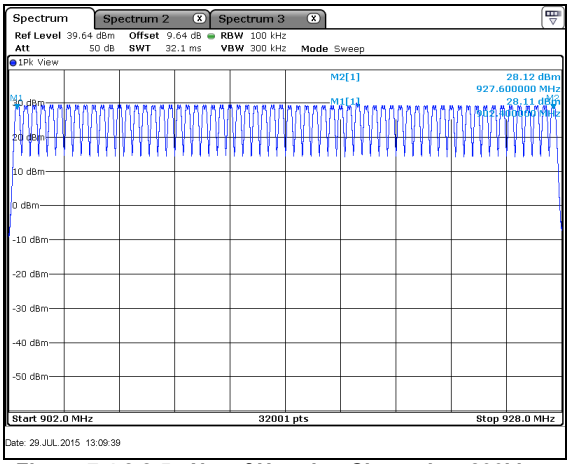


**Figure 7.4.2.2-5: No. of Hopping Channels – 200kbps**

### 7.4.3 Channel Dwell Time – FCC 15.247(a)(1)(i) IC: RSS-247 5.1(3)

#### 7.4.3.1 Measurement Procedure

The RF output port of the EUT was directly connected to the input of the spectrum analyzer using suitable attenuation. The span of the spectrum analyzer display was set 0 Hz centered on a hopping channel. The RBW of the spectrum analyzer was set to ≤ the EUT channel spacing and VBW set to ≥ RBW. The Marker Delta function of the analyzer was utilized to determine the dwell time.

#### 7.4.3.2 Measurement Results

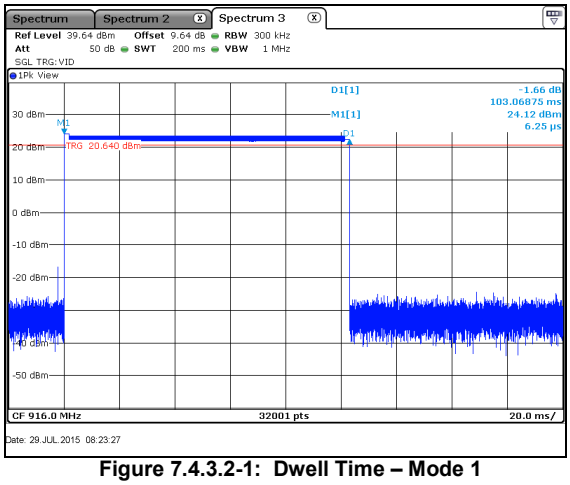


**Figure 7.4.3.2-1: Dwell Time – Mode 1**

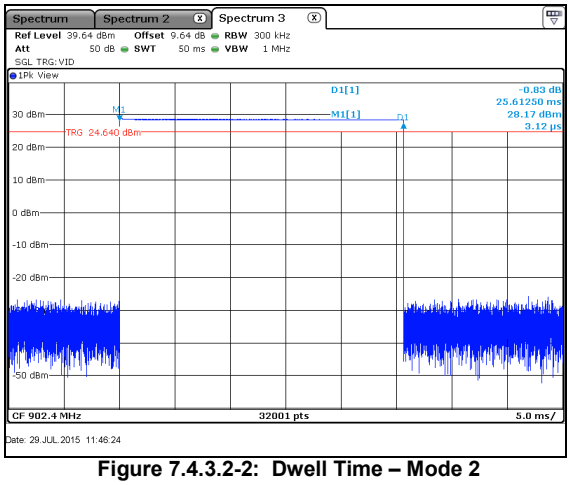


**Figure 7.4.3.2-2: Dwell Time – Mode 2**

*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.

### 7.4.4 20dB / 99% Bandwidth - FCC 15.247(a)(1)(i) IC: RSS-247 5.1(3)

#### 7.4.4.1 Measurement Procedure

The RF output port of the EUT was directly connected to the input of the spectrum analyzer using 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 marker delta measurement function of the analyzer was utilized to determine the 20 dB bandwidth of the emission.

The occupied bandwidth measurement function of the spectrum analyzer was used to measure the 99% bandwidth. The span of the analyzer was set to capture all products of the modulation process, including the emission sidebands. The resolution bandwidth was set to 1% to 5% of the occupied bandwidth. The video bandwidth was set to 3 times the resolution bandwidth. A peak detector was used.

#### 7.4.4.2 Measurement Results

**Table 7.4.4.2-1: 20dB / 99% Bandwidth**

| Frequency [MHz] | 20dB Bandwidth [kHz] | 99% Bandwidth [kHz] | Data Rate [kbps] |
|---|---|---|---|
| 902.4 | 355.77 | 371.61 | 35.5 |
| 902.4 | 333.12 | 318.24 | 142.2 |
| 902.4 | 116.35 | 117.22 | 50 |
| 902.4 | 189.90 | 194.62 | 150 |
| 902.4 | 260.49 | 253.90 | 200 |
| 916.0 | 319.68 | 371.30 | 35.5 |
| 916.0 | 332.93 | 318.30 | 142.2 |
| 916.0 | 116.14 | 117.07 | 50 |
| 916.0 | 189.92 | 194.06 | 150 |
| 916.0 | 260.52 | 253.65 | 200 |
| 927.6 | 319.37 | 370.77 | 35.5 |
| 927.6 | 332.87 | 317.90 | 142.2 |
| 927.6 | 116.00 | 116.93 | 50 |
| 927.6 | 189.84 | 193.57 | 150 |
| 927.6 | 260.34 | 253.59 | 200 |

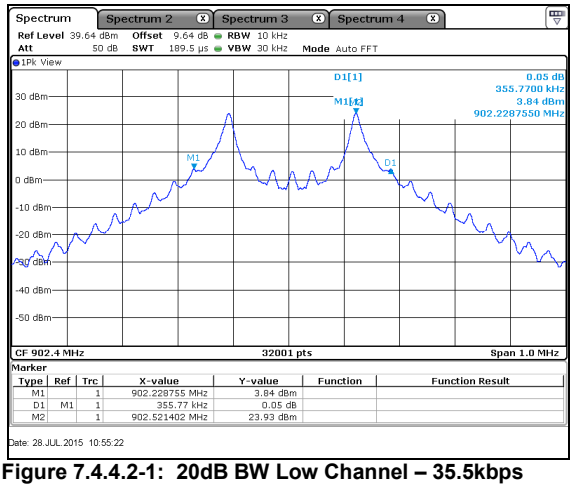


Figure 7.4.4.2-1: 20dB BW Low Channel – 35.5kbps

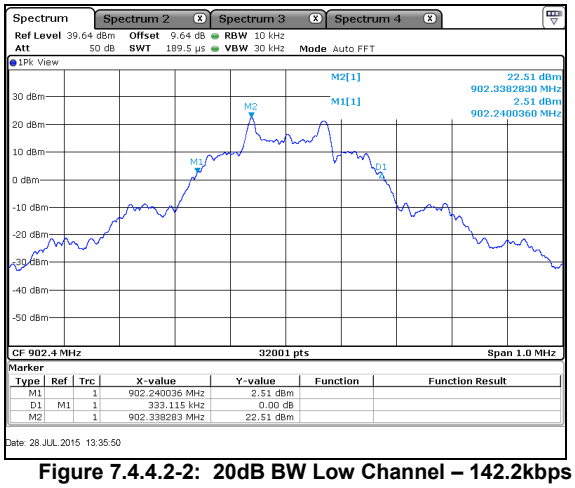


Figure 7.4.4.2-2: 20dB BW Low Channel – 142.2kbps

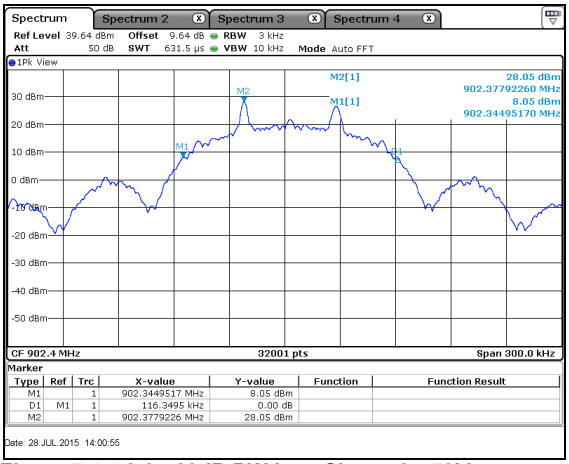


Figure 7.4.4.2-3: 20dB BW Low Channel – 50kbps

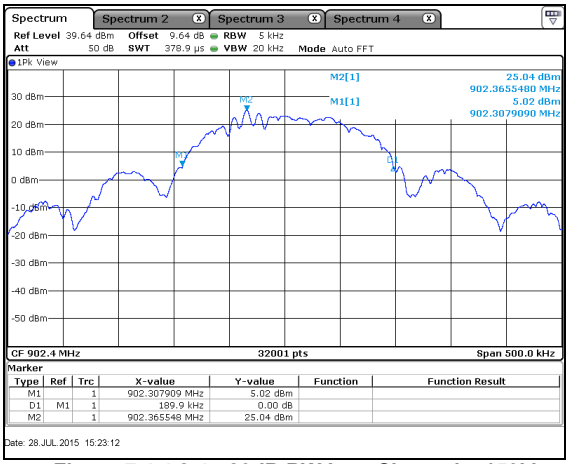


Figure 7.4.4.2-4: 20dB BW Low Channel – 150kbps

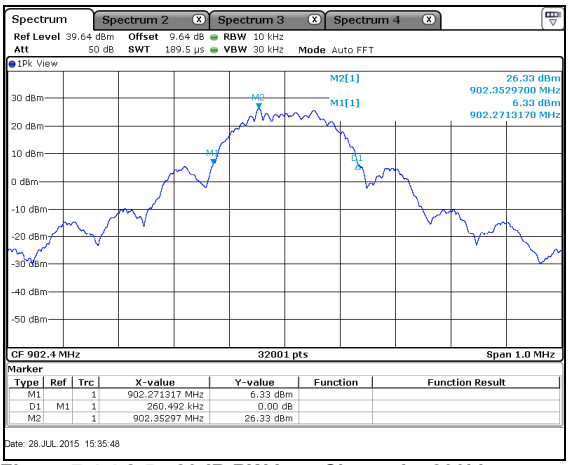


Figure 7.4.4.2-5: 20dB BW Low Channel – 200kbps

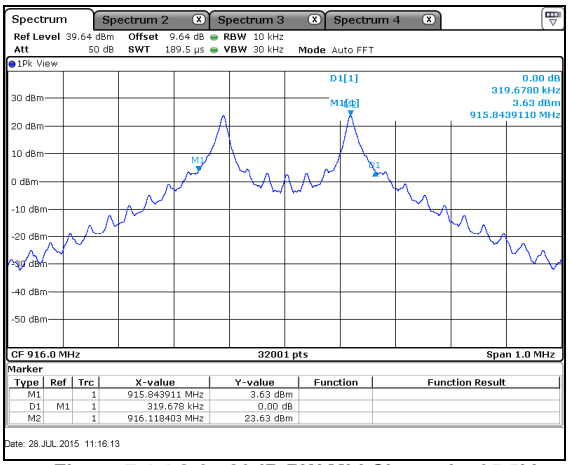


Figure 7.4.4.2-6: 20dB BW Mid Channel – 35.5kbps

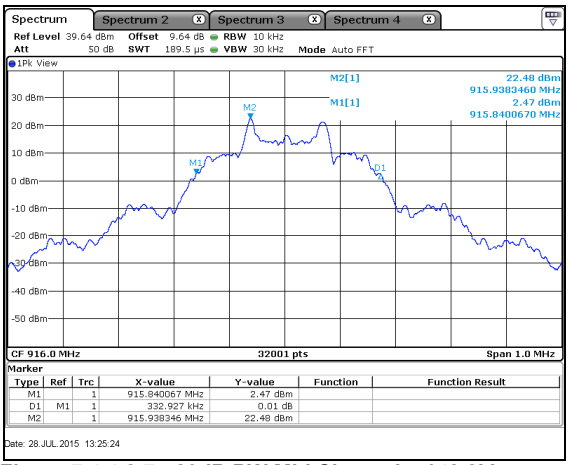


Figure 7.4.4.2-7: 20dB BW Mid Channel – 142.2kbps

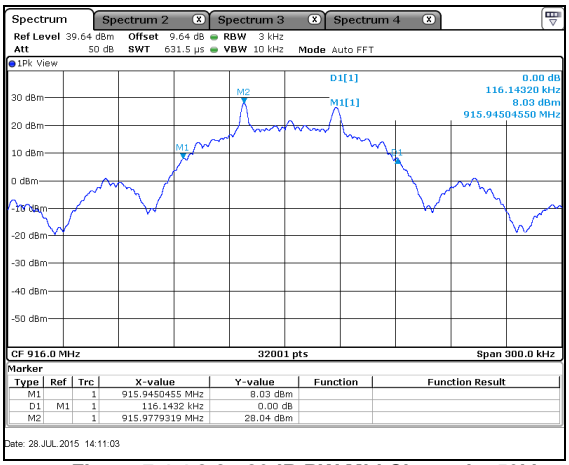


Figure 7.4.4.2-8: 20dB BW Mid Channel – 50kbps

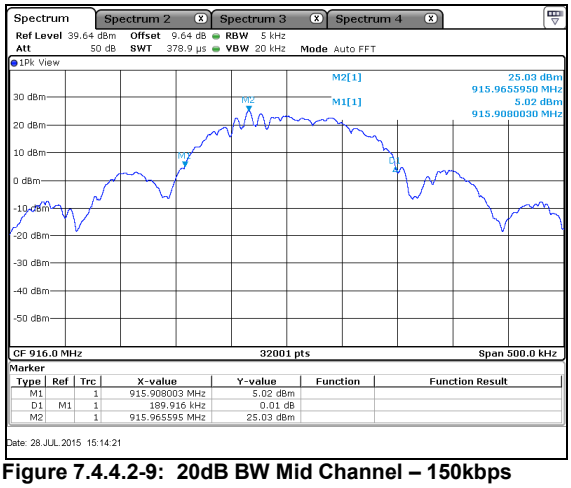


Figure 7.4.4.2-9: 20dB BW Mid Channel – 150kbps

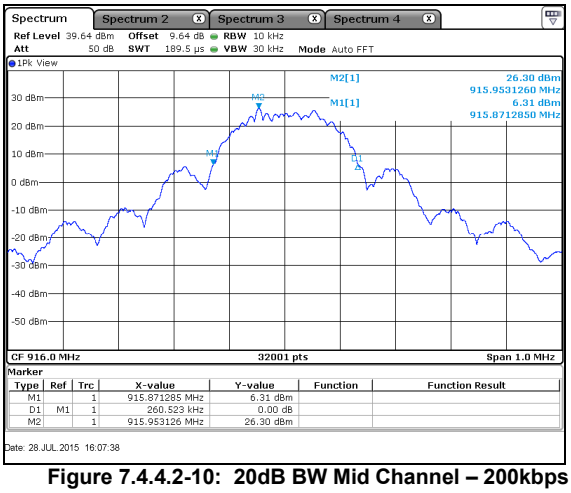


Figure 7.4.4.2-10: 20dB BW Mid Channel – 200kbps

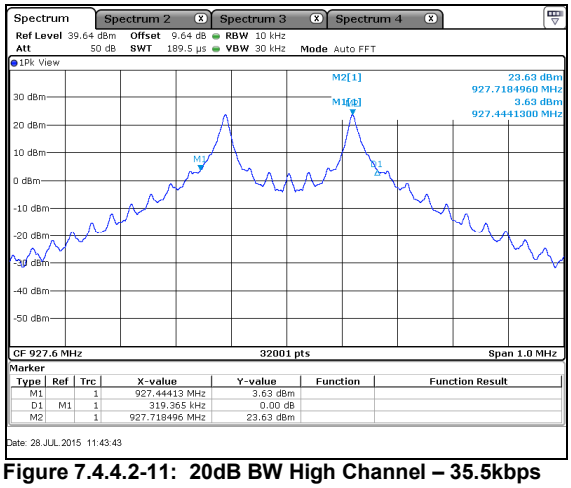


Figure 7.4.4.2-11: 20dB BW High Channel – 35.5kbps

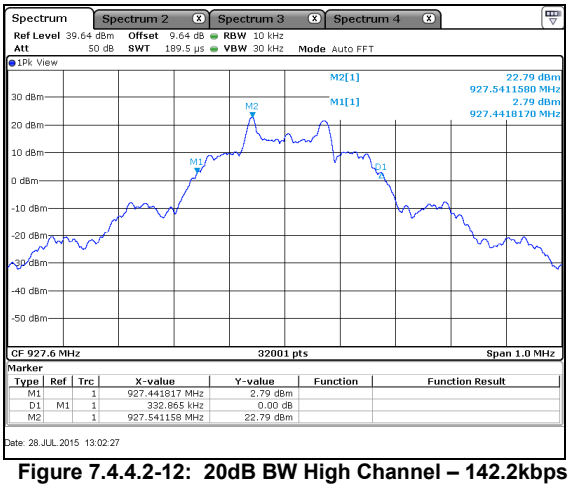


Figure 7.4.4.2-12: 20dB BW High Channel – 142.2kbps

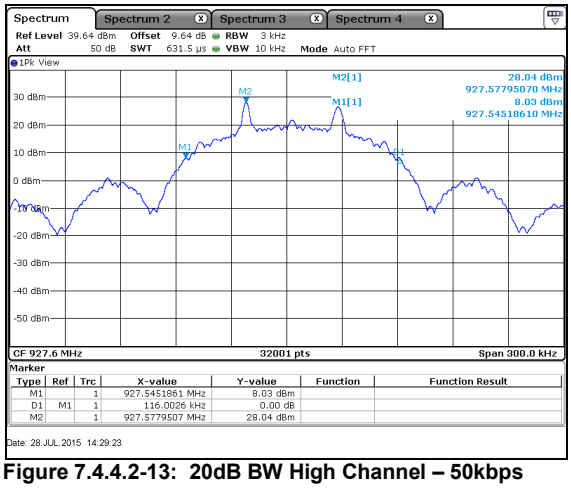


Figure 7.4.4.2-13: 20dB BW High Channel – 50kbps

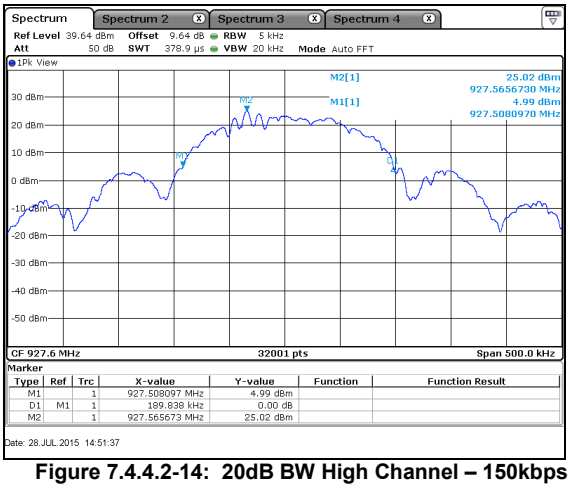


Figure 7.4.4.2-14: 20dB BW High Channel – 150kbps

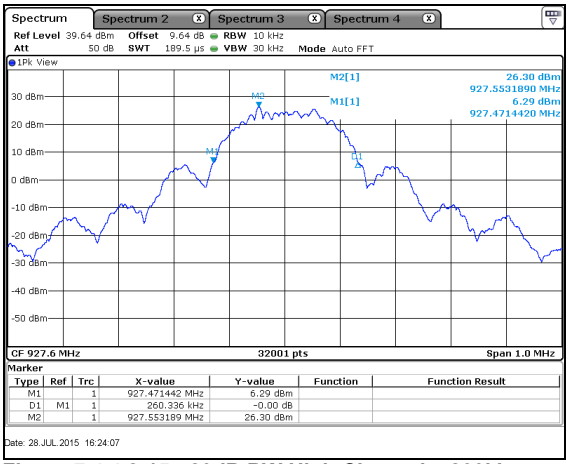


Figure 7.4.4.2-15: 20dB BW High Channel – 200kbps

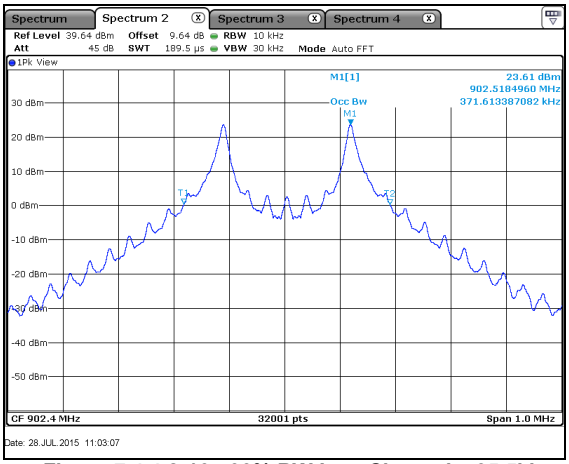


Figure 7.4.4.2-16: 99% BW Low Channel – 35.5kbps

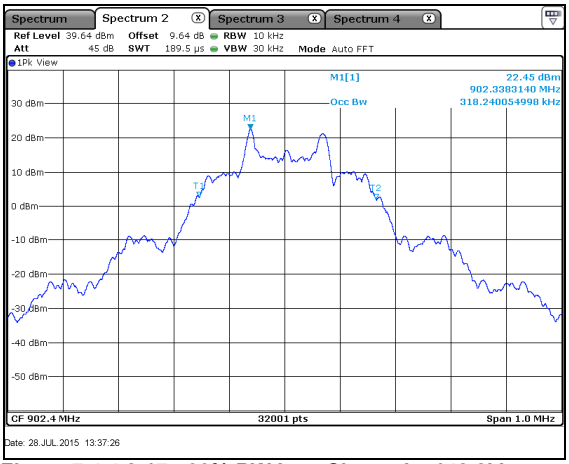


Figure 7.4.4.2-17: 99% BW Low Channel – 142.2kbps

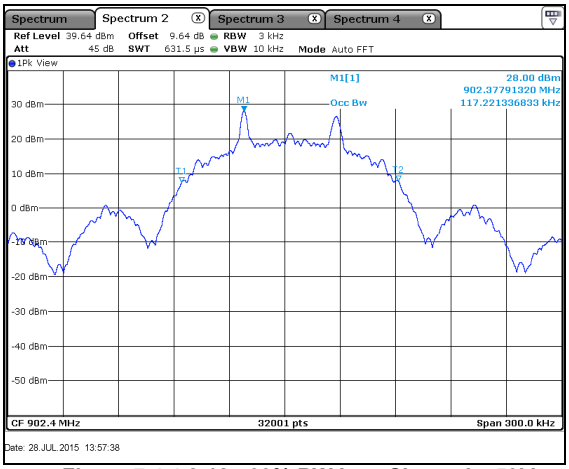


Figure 7.4.4.2-18: 99% BW Low Channel – 50kbps

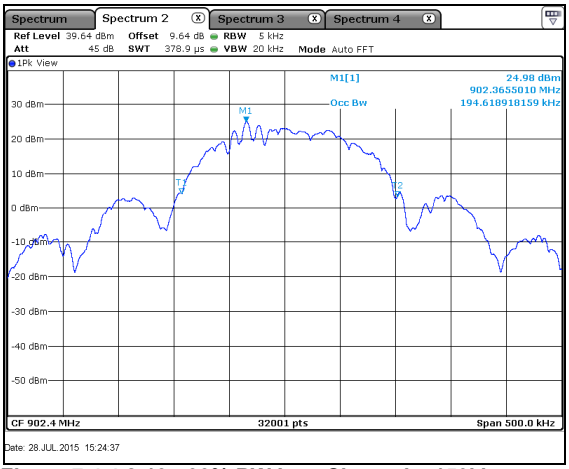


Figure 7.4.4.2-19: 99% BW Low Channel – 150kbps

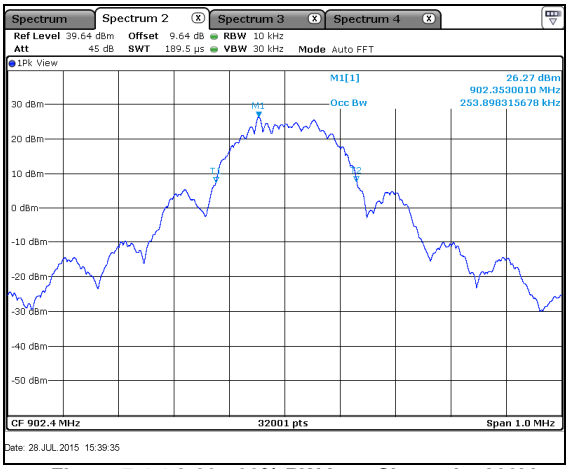


Figure 7.4.4.2-20: 99% BW Low Channel – 200kbps

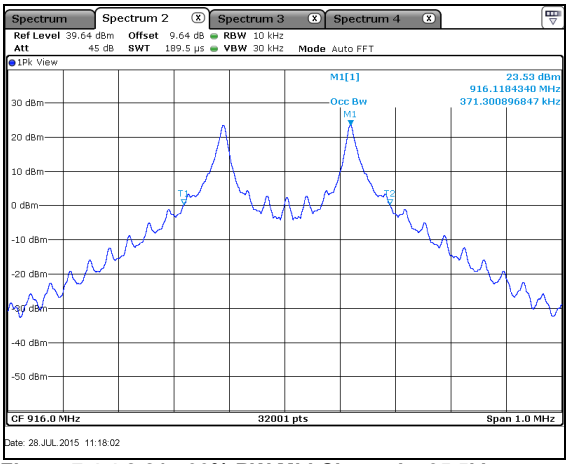


Figure 7.4.4.2-21: 99% BW Mid Channel – 35.5kbps

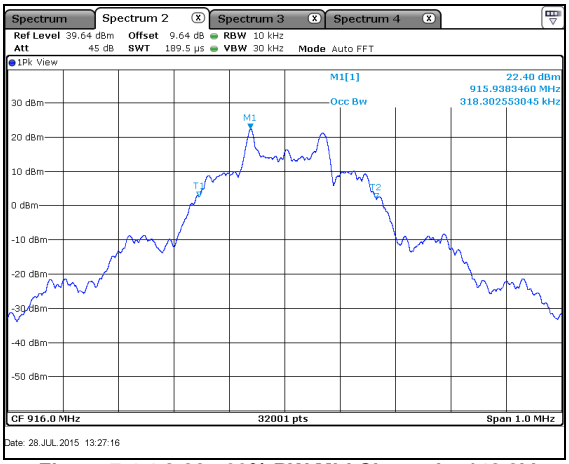


Figure 7.4.4.2-22: 99% BW Mid Channel – 142.2kbps

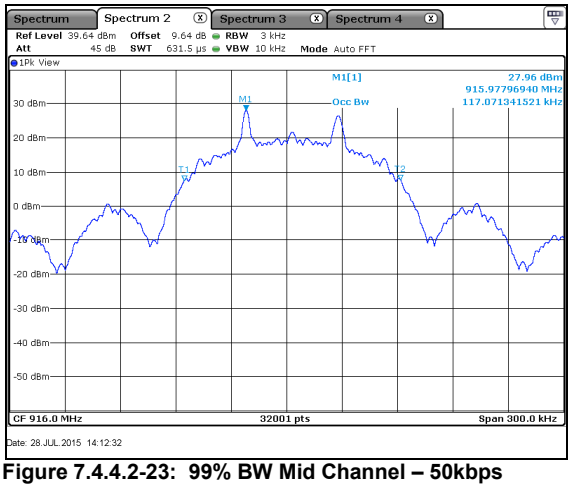


Figure 7.4.4.2-23: 99% BW Mid Channel – 50kbps

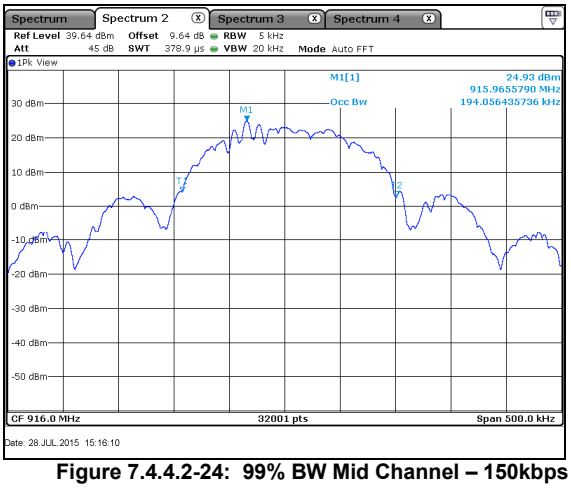


Figure 7.4.4.2-24: 99% BW Mid Channel – 150kbps

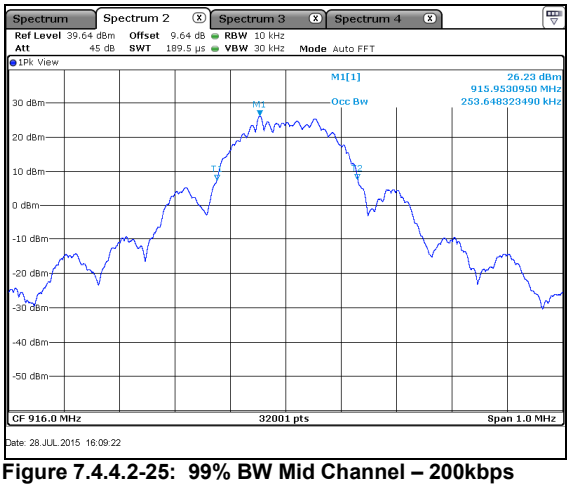


Figure 7.4.4.2-25: 99% BW Mid Channel – 200kbps

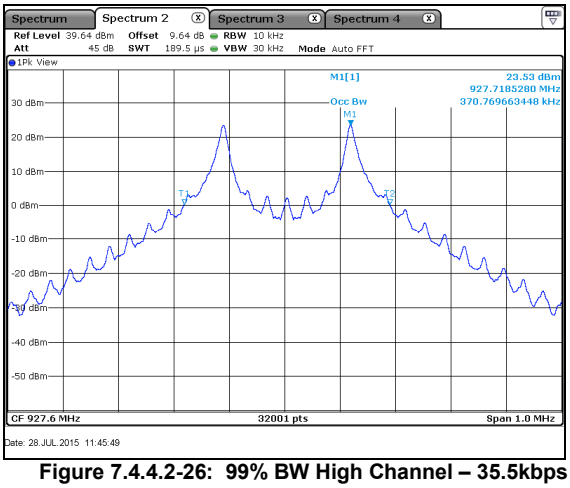


Figure 7.4.4.2-26: 99% BW High Channel – 35.5kbps

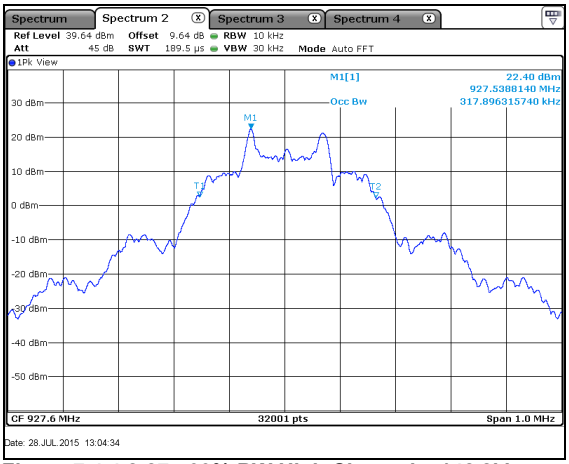


Figure 7.4.4.2-27: 99% BW High Channel – 142.2kbps

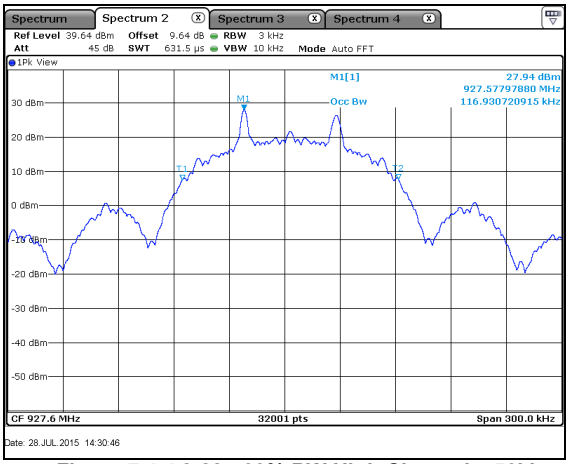


Figure 7.4.4.2-28: 99% BW High Channel – 50kbps

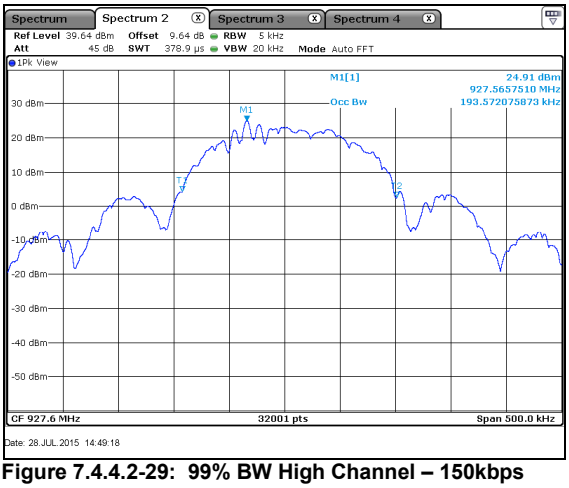


Figure 7.4.4.2-29: 99% BW High Channel – 150kbps

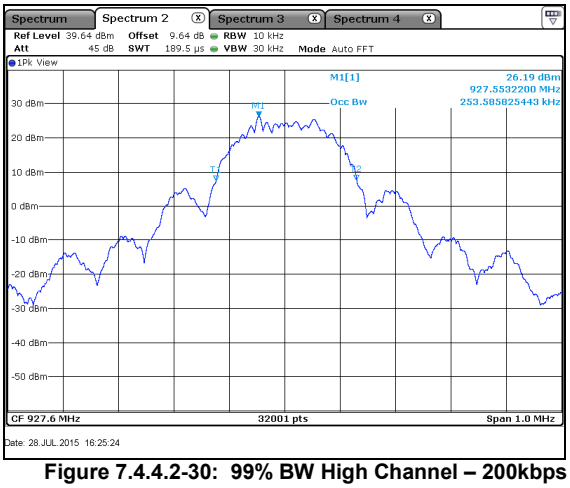


Figure 7.4.4.2-30: 99% BW High Channel – 200kbps

## 7.5 Band-Edge Compliance and Spurious Emissions

### 7.5.1 Band-Edge Compliance of RF Conducted Emissions - FCC 15.247(d); IC RSS-247 5.5

#### 7.5.1.1 Measurement Procedure

The RF output port of the EUT was directly connected to the input of the spectrum analyzer using 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.

#### 7.5.1.2 Measurement Results

**NON-HOPPING MODE:**

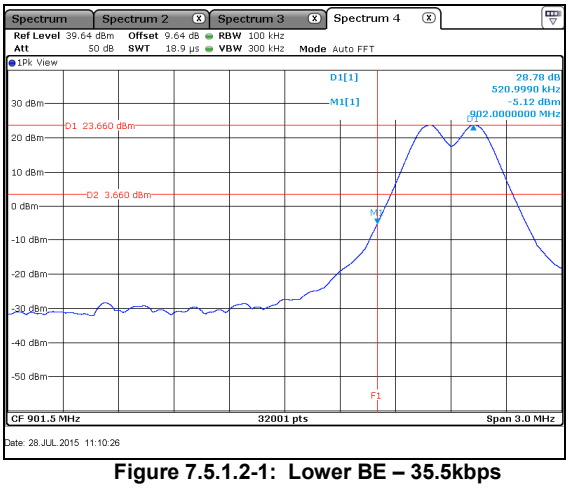


Figure 7.5.1.2-1: Lower BE – 35.5kbps

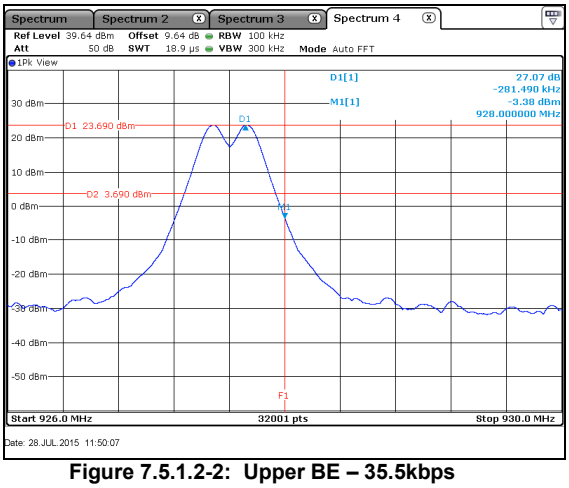


Figure 7.5.1.2-2: Upper BE – 35.5kbps

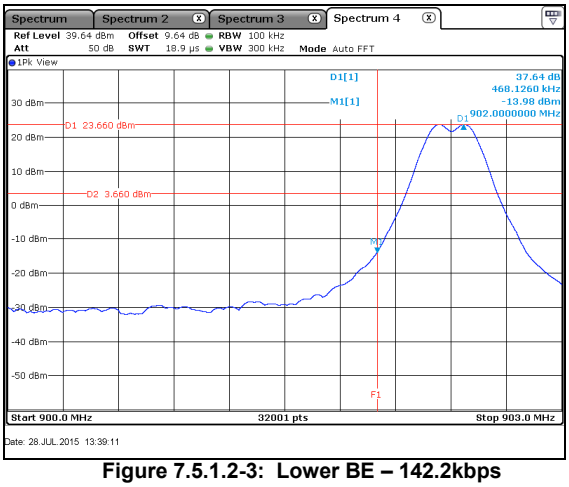


Figure 7.5.1.2-3: Lower BE – 142.2kbps

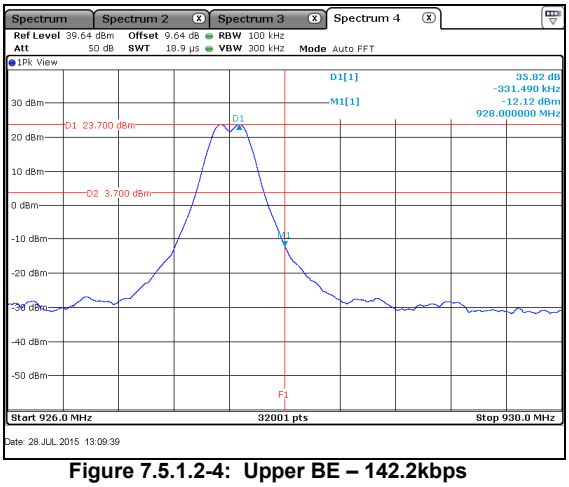


Figure 7.5.1.2-4: Upper BE – 142.2kbps

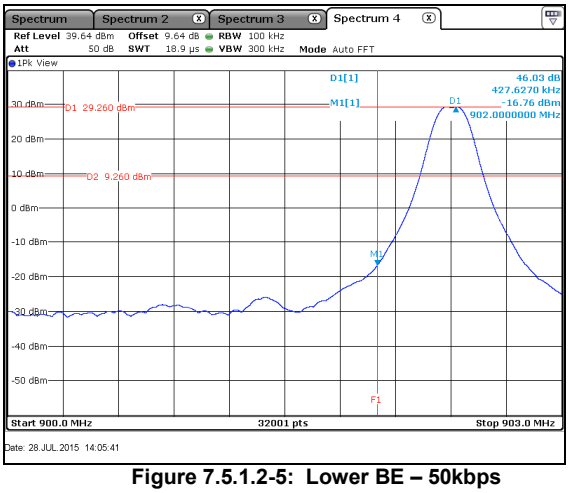


Figure 7.5.1.2-5: Lower BE – 50kbps

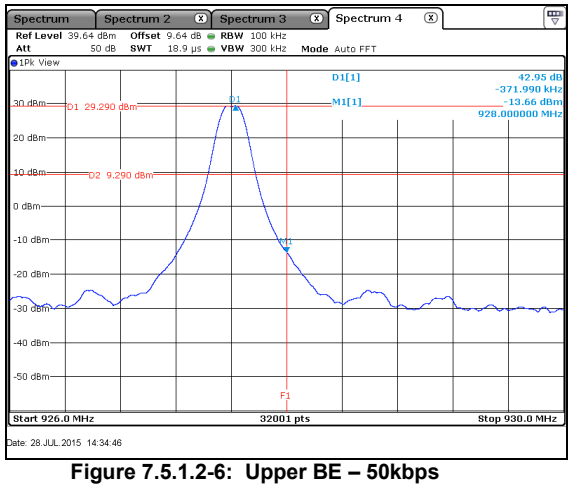


Figure 7.5.1.2-6: Upper BE – 50kbps

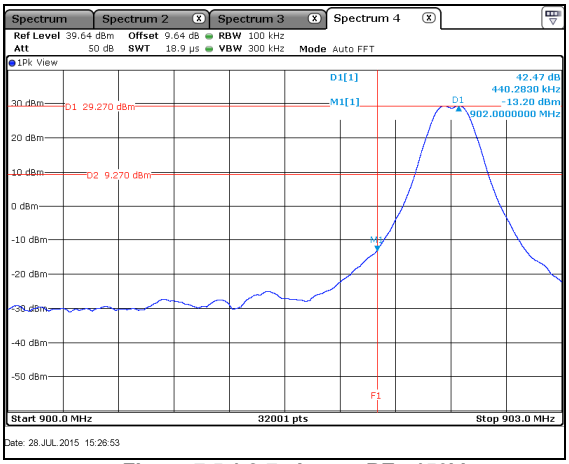


Figure 7.5.1.2-7: Lower BE– 150kbps

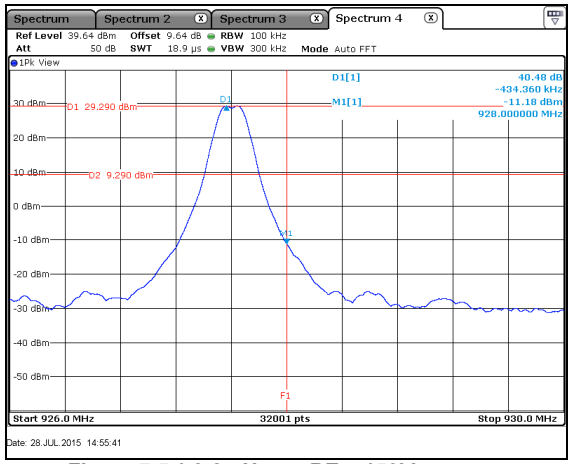


Figure 7.5.1.2-8: Upper BE – 150kbps

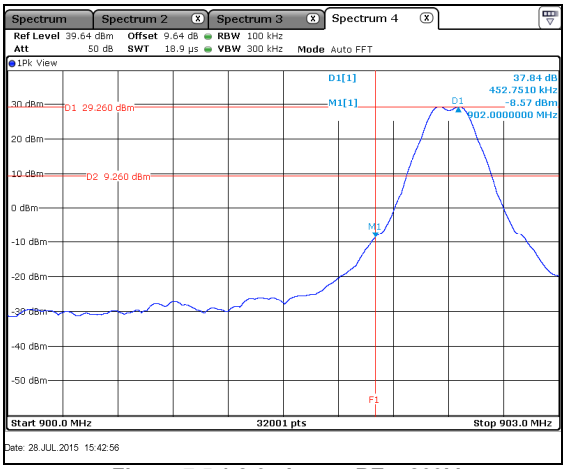


Figure 7.5.1.2-9: Lower BE – 200kbps

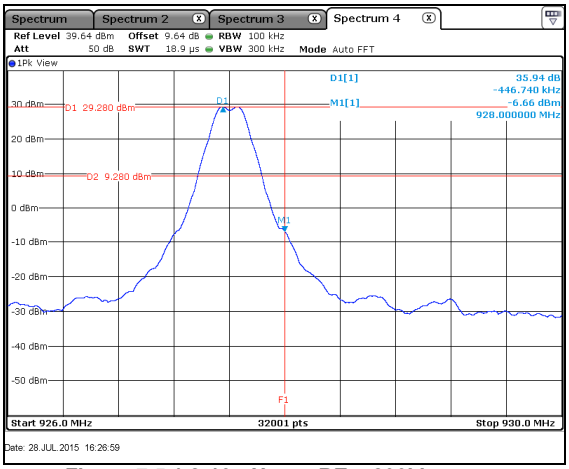


Figure 7.5.1.2-10: Upper BE – 200kbps

## HOPPING MODE:

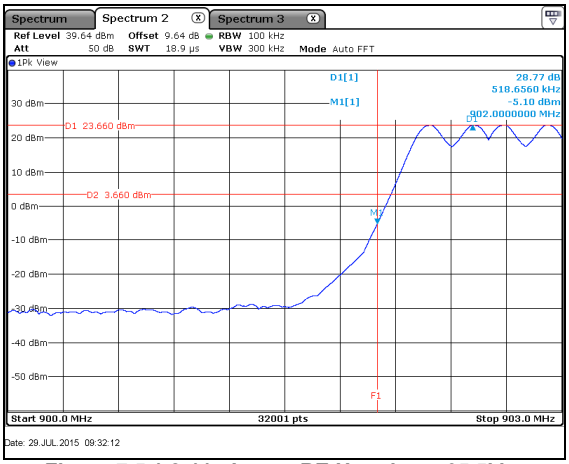


Figure 7.5.1.2-11: Lower BE Hopping – 35.5kbps

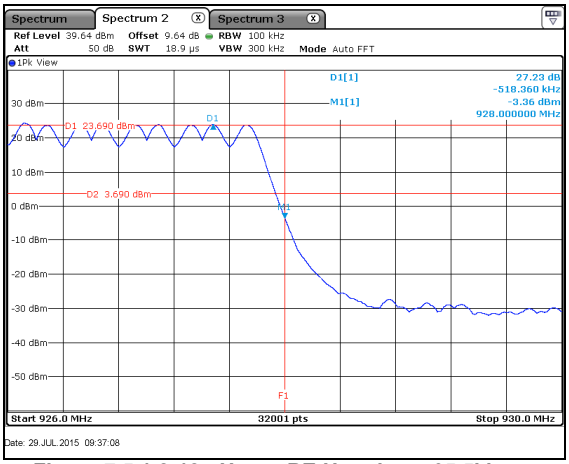


Figure 7.5.1.2-12: Upper BE Hopping – 35.5kbps

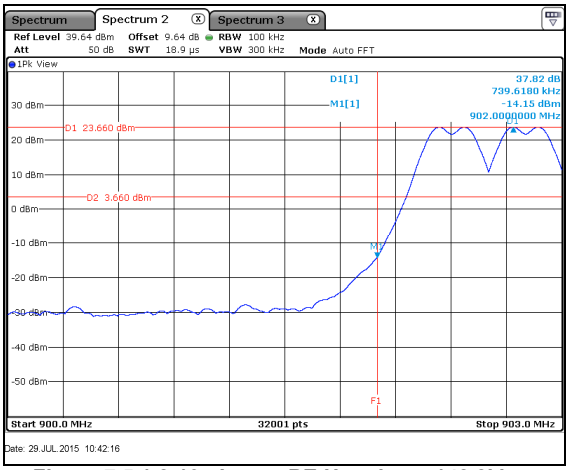


Figure 7.5.1.2-13: Lower BE Hopping – 142.2kbps

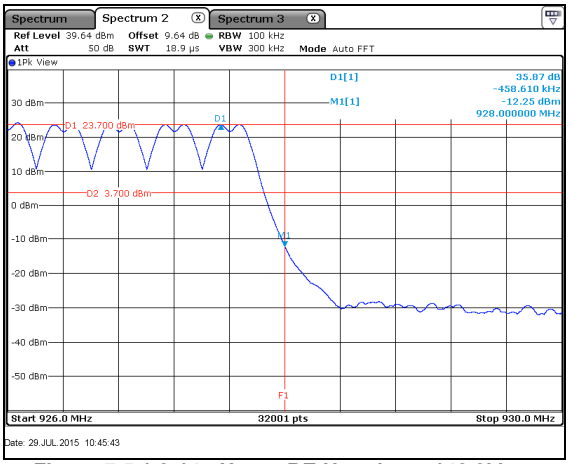


Figure 7.5.1.2-14: Upper BE Hopping – 142.2kbps

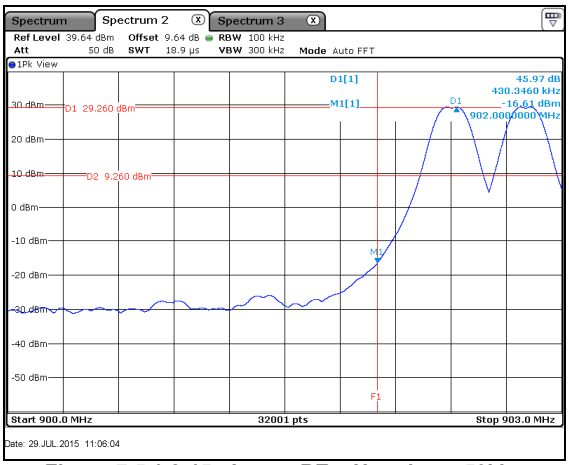


Figure 7.5.1.2-15: Lower BE – Hopping – 50kbps

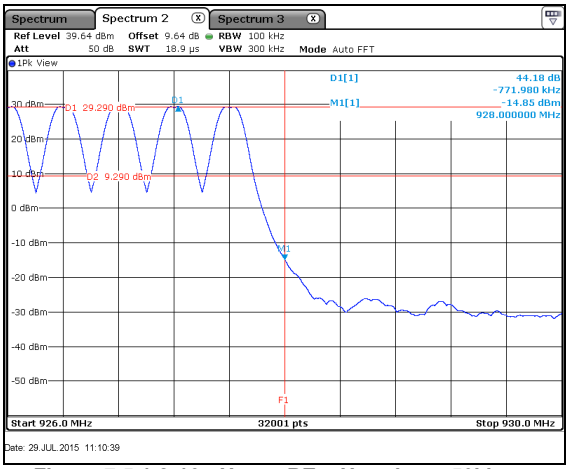


Figure 7.5.1.2-16: Upper BE – Hopping – 50kbps

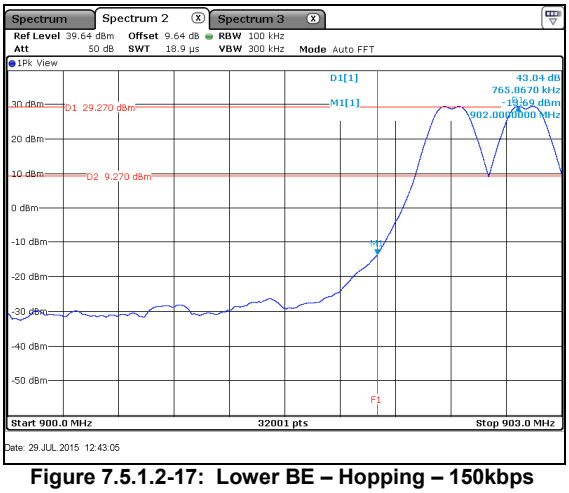


Figure 7.5.1.2-17: Lower BE – Hopping – 150kbps

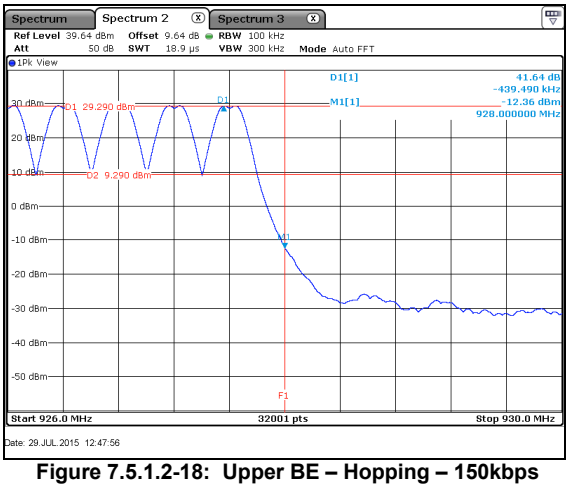


Figure 7.5.1.2-18: Upper BE – Hopping – 150kbps

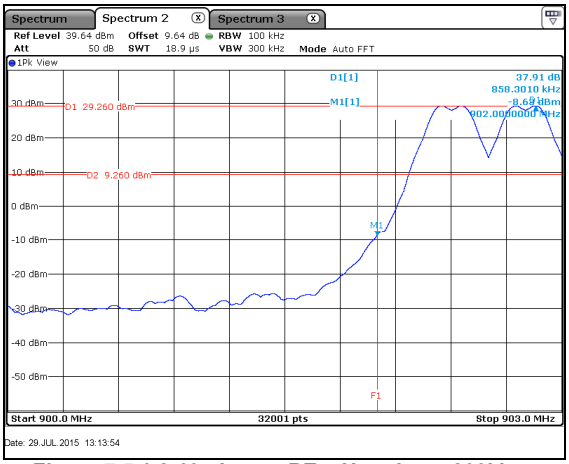


Figure 7.5.1.2-19: Lower BE – Hopping – 200kbps

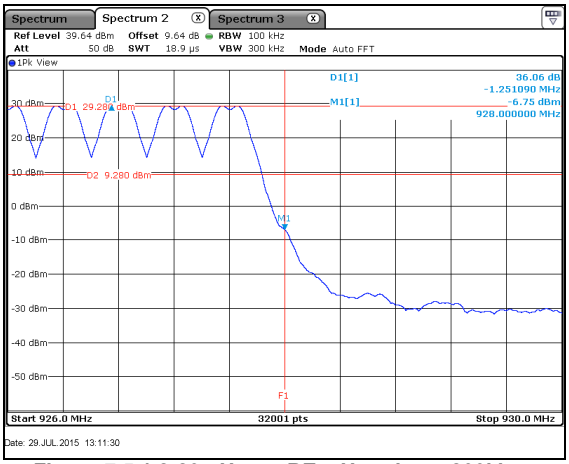


Figure 7.5.1.2-20: Upper BE – Hopping – 200kbps

### 7.5.2 RF Conducted Spurious Emissions - FCC 15.247(d); IC RSS-247 5.5

#### 7.5.2.1 Measurement Procedure

The RF output port of the EUT was directly connected to the input of the spectrum analyzer using 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.

#### 7.5.2.2 Measurement Results

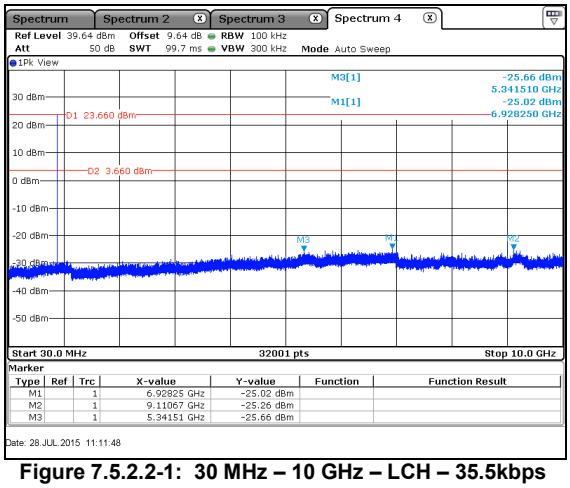


**Figure 7.5.2.2-1: 30 MHz – 10 GHz – LCH – 35.5kbps**

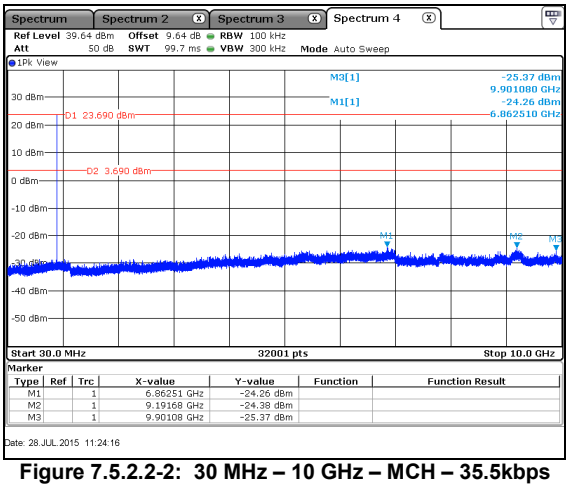


**Figure 7.5.2.2-2: 30 MHz – 10 GHz – MCH – 35.5kbps**

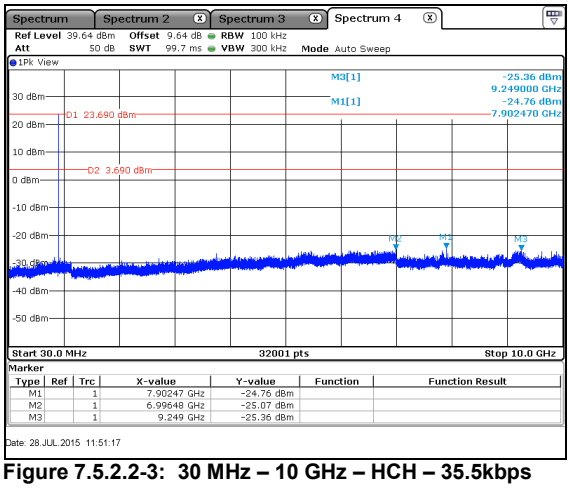


**Figure 7.5.2.2-3: 30 MHz – 10 GHz – HCH – 35.5kbps**

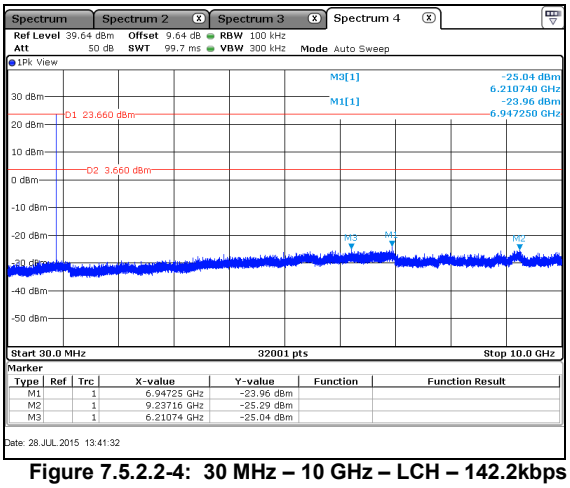


**Figure 7.5.2.2-4: 30 MHz – 10 GHz – LCH – 142.2kbps**

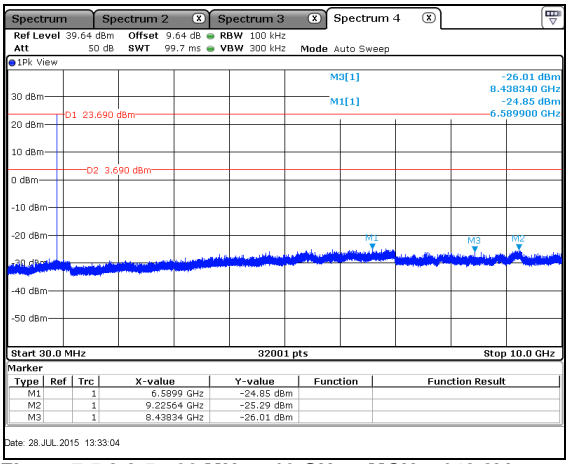


Figure 7.5.2.2-5: 30 MHz – 10 GHz – MCH – 142.2kbps

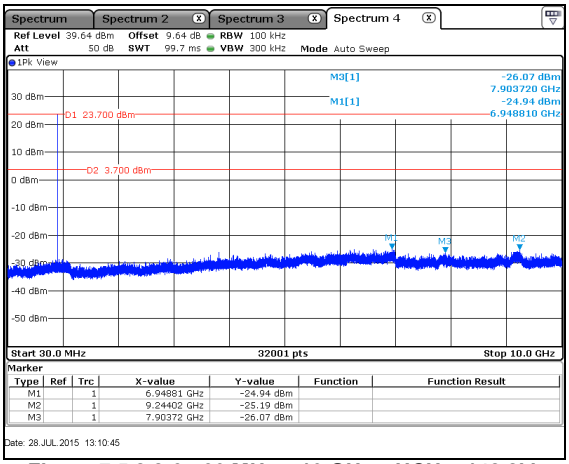


Figure 7.5.2.2-6: 30 MHz – 10 GHz – HCH – 142.2kbps

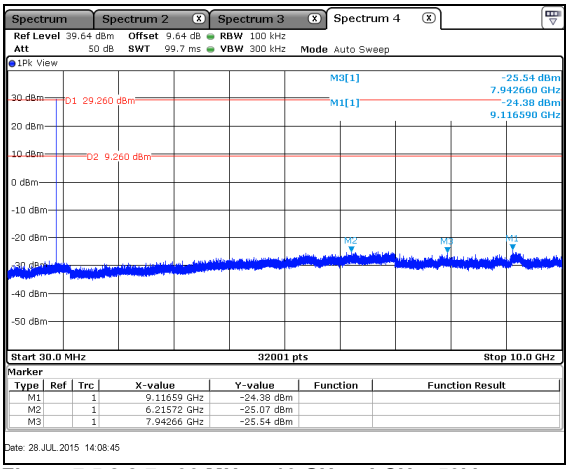


Figure 7.5.2.2-7: 30 MHz – 10 GHz – LCH – 50kbps

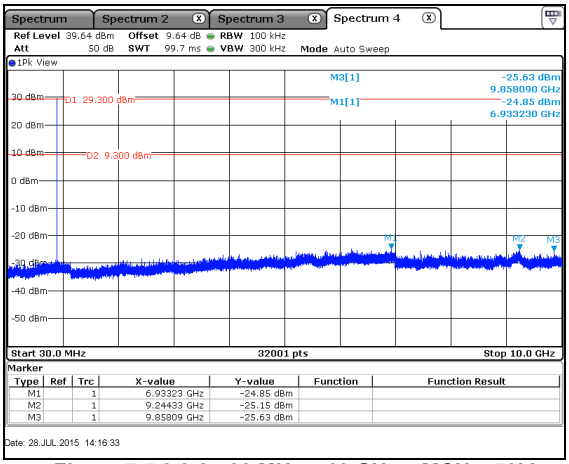


Figure 7.5.2.2-8: 30 MHz – 10 GHz – MCH – 50kbps

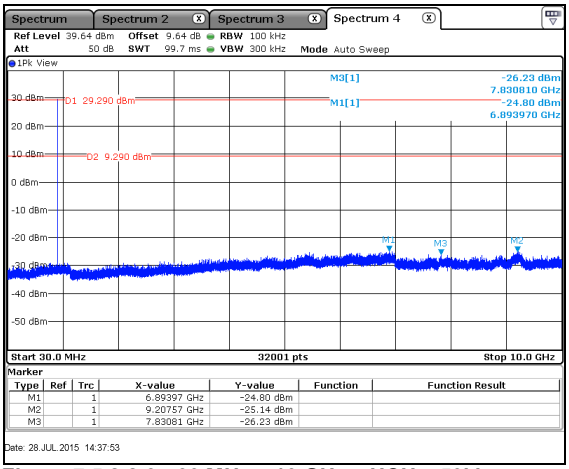


Figure 7.5.2.2-9: 30 MHz – 10 GHz – HCH – 50kbps

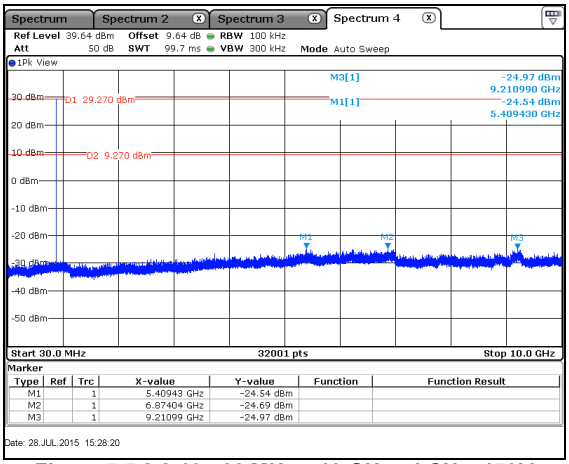


Figure 7.5.2.2-10: 30 MHz – 10 GHz – LCH – 150kbps

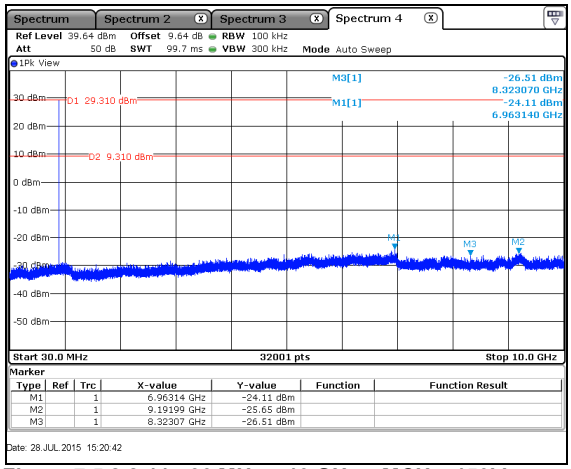


Figure 7.5.2.2-11: 30 MHz – 10 GHz – MCH – 150kbps

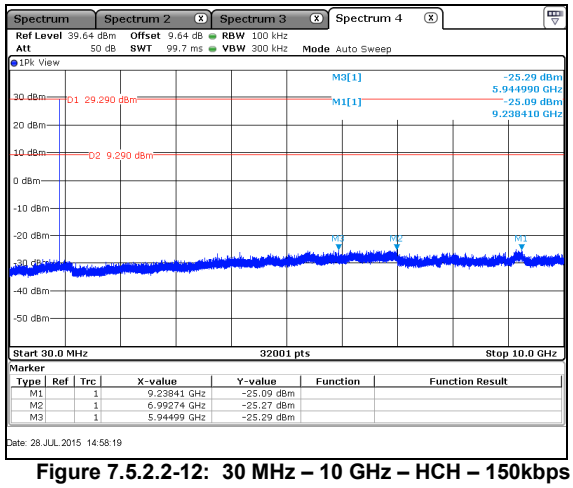


Figure 7.5.2.2-12: 30 MHz – 10 GHz – HCH – 150kbps

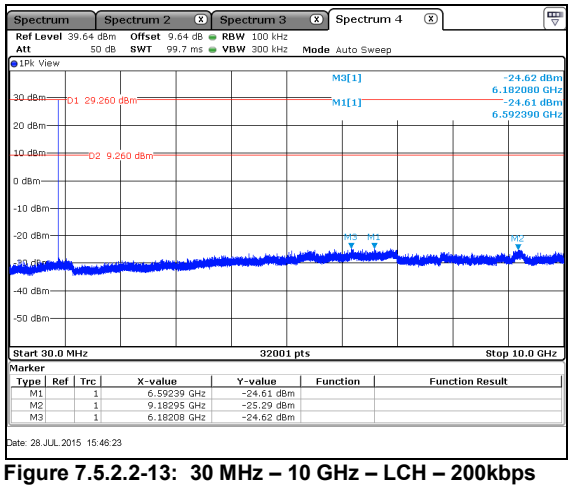


Figure 7.5.2.2-13: 30 MHz – 10 GHz – LCH – 200kbps

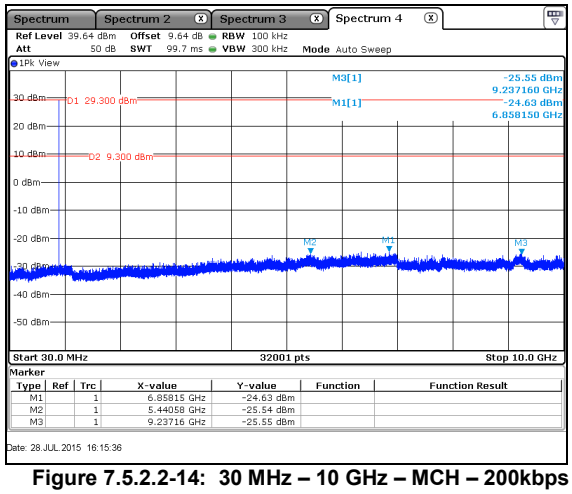


Figure 7.5.2.2-14: 30 MHz – 10 GHz – MCH – 200kbps

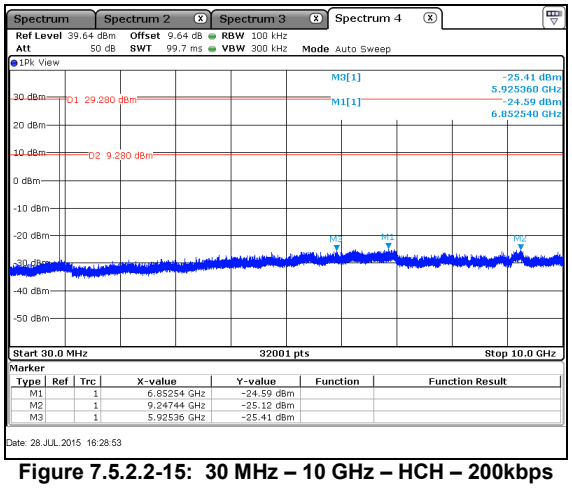


Figure 7.5.2.2-15: 30 MHz – 10 GHz – HCH – 200kbps

### 7.5.3 Radiated Spurious Emissions - FCC 15.205, 15.209; RSS-Gen 8.9/8.10

#### 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.

#### 7.5.3.2 Measurement Results

**Table 7.5.3.2-1: Radiated Spurious Emissions Tabulated Data – Mode 1**

| 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** | | | | | | | | | | |
| **2707.2** | 47.45 | 36.40 | H | -4.56 | 42.89 | 31.84 | 74.0 | 54.0 | 31.1 | 22.2 |
| **2707.2** | 51.34 | 36.91 | V | -4.56 | 46.78 | 32.35 | 74.0 | 54.0 | 27.2 | 21.6 |
| **Middle Channel** | | | | | | | | | | |
| **2748** | 48.31 | 37.34 | H | -4.41 | 43.90 | 32.93 | 74.0 | 54.0 | 30.1 | 21.1 |
| **2748** | 48.25 | 38.61 | V | -4.41 | 43.84 | 34.20 | 74.0 | 54.0 | 30.2 | 19.8 |
| **High Channel** | | | | | | | | | | |
| **2782.8** | 47.23 | 35.41 | H | -4.29 | 42.94 | 31.12 | 74.0 | 54.0 | 31.1 | 22.9 |
| **2782.8** | 50.17 | 36.84 | V | -4.29 | 45.88 | 32.55 | 74.0 | 54.0 | 28.1 | 21.4 |
| **4638** | 48.39 | 40.24 | H | 0.90 | 49.29 | 41.14 | 74.0 | 54.0 | 24.7 | 12.9 |
| **4638** | 49.11 | 40.64 | V | 0.90 | 50.01 | 41.54 | 74.0 | 54.0 | 24.0 | 12.5 |

**Table 7.5.3.2-2: Radiated Spurious Emissions Tabulated Data – Mode 2**

| 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** | | | | | | | | | | |
| **2707.2** | 56.11 | 46.13 | H | -4.56 | 51.55 | 41.57 | 74.0 | 54.0 | 22.4 | 12.4 |
| **2707.2** | 60.88 | 49.91 | V | -4.56 | 56.32 | 45.35 | 74.0 | 54.0 | 17.7 | 8.6 |
| **3609.6** | 54.91 | 41.53 | H | -1.30 | 53.61 | 40.23 | 74.0 | 54.0 | 20.4 | 13.8 |
| **3609.6** | 55.09 | 43.03 | V | -1.30 | 53.79 | 41.73 | 74.0 | 54.0 | 20.2 | 12.3 |
| **4512** | 50.42 | 41.53 | H | 0.78 | 51.20 | 42.31 | 74.0 | 54.0 | 22.8 | 11.7 |
| **4512** | 52.32 | 43.64 | V | 0.78 | 53.10 | 44.42 | 74.0 | 54.0 | 20.9 | 9.6 |
| **5414.4** | 48.18 | 41.15 | H | 3.17 | 51.35 | 44.32 | 74.0 | 54.0 | 22.6 | 9.7 |
| **5414.4** | 48.56 | 41.68 | V | 3.17 | 51.73 | 44.85 | 74.0 | 54.0 | 22.3 | 9.1 |
| **Middle Channel** | | | | | | | | | | |
| **2748** | 55.98 | 47.85 | H | -4.41 | 51.57 | 43.44 | 74.0 | 54.0 | 22.4 | 10.6 |
| **2748** | 62.35 | 53.11 | V | -4.41 | 57.94 | 48.70 | 74.0 | 54.0 | 16.1 | 5.3 |
| **3664** | 54.02 | 41.61 | H | -1.11 | 52.91 | 40.50 | 74.0 | 54.0 | 21.1 | 13.5 |
| **3664** | 55.29 | 42.42 | V | -1.11 | 54.18 | 41.31 | 74.0 | 54.0 | 19.8 | 12.7 |
| **4580** | 50.84 | 42.27 | H | 0.85 | 51.69 | 43.12 | 74.0 | 54.0 | 22.3 | 10.9 |
| **4580** | 51.18 | 44.53 | V | 0.85 | 52.03 | 45.38 | 74.0 | 54.0 | 22.0 | 8.6 |
| **High Channel** | | | | | | | | | | |
| **2782.8** | 55.32 | 44.17 | H | -4.29 | 51.03 | 39.88 | 74.0 | 54.0 | 23.0 | 14.1 |
| **2782.8** | 62.70 | 52.60 | V | -4.29 | 58.41 | 48.31 | 74.0 | 54.0 | 15.6 | 5.7 |
| **3710.4** | 55.08 | 42.57 | H | -0.94 | 54.14 | 41.63 | 74.0 | 54.0 | 19.9 | 12.4 |
| **3710.4** | 54.61 | 41.86 | V | -0.94 | 53.67 | 40.92 | 74.0 | 54.0 | 20.3 | 13.1 |
| **4638** | 50.86 | 43.59 | H | 0.90 | 51.76 | 44.49 | 74.0 | 54.0 | 22.2 | 9.5 |
| **4638** | 52.95 | 47.19 | V | 0.90 | 53.85 | 48.09 | 74.0 | 54.0 | 20.1 | 5.9 |

**Table 7.5.3.2-3: Radiated Spurious Emissions Tabulated Data – 30MHz – 1GHz**

| 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 |
| **38.12** | | 48.09 | V | -13.69 | --------- | 34.40 | -------- | 40.0 | --------- | 5.6 |
| **75.17** | | 47.15 | V | -17.52 | --------- | 29.63 | -------- | 40.0 | --------- | 10.4 |
| **135.5** | | 56.52 | H | -13.24 | --------- | 43.28 | -------- | 43.5 | --------- | 0.2 |
| **164** | | 52.60 | V | -9.20 | --------- | 43.40 | -------- | 43.5 | --------- | 0.1 |
| **248** | | 46.31 | H | -12.42 | --------- | 33.89 | -------- | 46.0 | --------- | 12.1 |
| **960** | | 32.09 | V | 2.20 | --------- | 34.29 | -------- | 46.0 | --------- | 11.7 |
| **979.94** | | 36.10 | H | 1.80 | --------- | 37.90 | -------- | 54.0 | --------- | 16.1 |
| **979.94** | | 35.47 | V | 1.80 | --------- | 37.27 | -------- | 54.0 | --------- | 16.7 |

### 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: 47.45 - 4.56 = 42.89dBuV/m
Margin: 74dBuV/m – 42.89dBuV/m = 31.1dB

**Example Calculation: Average**

Corrected Level: 36.40 - 4.56 - 0 = 31.84dBuV
Margin: 54dBuV – 31.84dBuV = 22.2dB

## 8 CONCLUSION

In the opinion of ACS, Inc. the REXUA, manufactured by Elster Solutions, LLC meets the requirements of FCC Part 15 subpart C and Industry Canada's Radio Standards Specification RSS-247.

# END REPORT