Excellence in Compliance Testing

Certification Test Report

FCC ID: QZC-MRX2EA4

FCC Rule Part: 15.247

ACS Report Number: 15-0127.W03.1A

Manufacturer: Elster Solutions, LLC
Model: MRX2EA4

Test Begin Date: April 15, 2015
Test End Date: April 17, 2015

Report Issue Date: July 1, 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 28 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.

1.2 Product description

The MRX2EA4 Printed Circuit Board Assembly (PCBA) contains a frequency hopping spread spectrum radio operating in the 902.4-927.6 MHz ISM frequency band. It also contains circuitry for electricity metering. When the MRX2EA4 module is installed in a plastic housing it forms a complete electricity meter.

Technical Details:

Detail	Description
Frequency Range	902.4 – 927.6 MHz
Number of Channels	25
Modulation Format	FSK
Data Rate	35.5kbps/142 kbps
Operating Voltage	4.5 VDC

Antenna Details:

Item #	Antenna	Gain	Internal / External
1	PCTEL(MAXRAD) MFB9153 3dB Fiberglass Omnidirectional	5.15 dBi	External
2	PCTEL(MAXRAD) MFB9150 Unity Gain Fiberglass Omnidirectional	2.15 dBi	External
3	Antenex TRA9023P(NP)* [white body] 3dB Gain	3 dBi	External
4	Antenex TRAB9023P(NP)* [black body] 3dB Gain	3 dBi	External
5	On Board Printed Monopole	0.8dBi	Internal
6	Larson LP800 Unity Gain Direct Feed Low Profile	2dBi	External

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

EUT Serial Numbers: 5D26146GXX01 0 5145100047 (Radiated),5D26146GXX01 0 514510007 (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 tested in three orthogonal orientations to determine the worst case orientation. The worst case orientation was the Z position.

The highest gain of each antenna type was evaluated for radiated emissions.

The EUT utilizes 25 hopping channels in the range from 902.4 MHz to 927.6 MHz using multiple hopping tables. The EUT was evaluated for (4) channels within the operating range to assist with international regulatory approval. 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).

For use with external antennas, the EUT utilizes a passive isolation board between the RF output and antenna. The isolation board was used in the test setup for testing external antennas and will be included in the final installation.

Radiated inter-modulation testing was performed with twelve MRX2EA4 radios installed in a MREX2 cabinet (typical host) for all combinations of simultaneous transmission. Radiated inter-modulation testing was found to be in compliance.

Software power setting during test: 104

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:

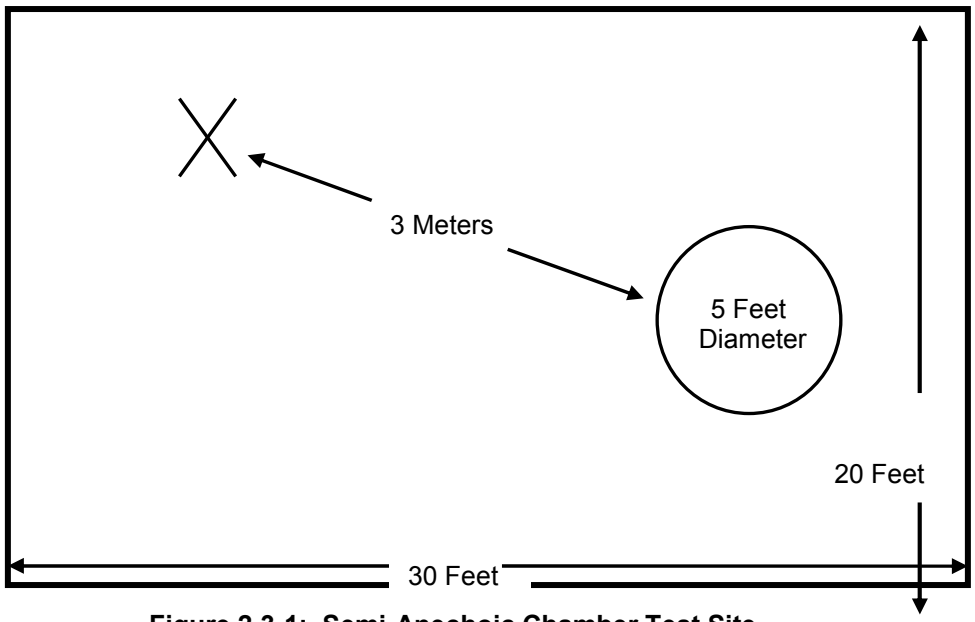

Figure 2.3-1: Semi-Anechoic Chamber Test Site

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:

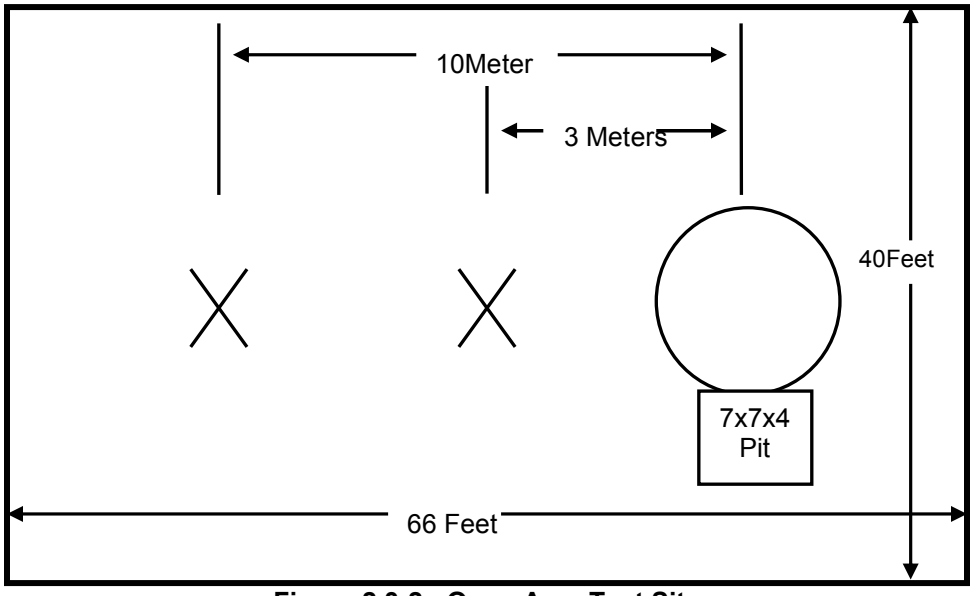

Figure 2.3-2: Open Area Test Site

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:

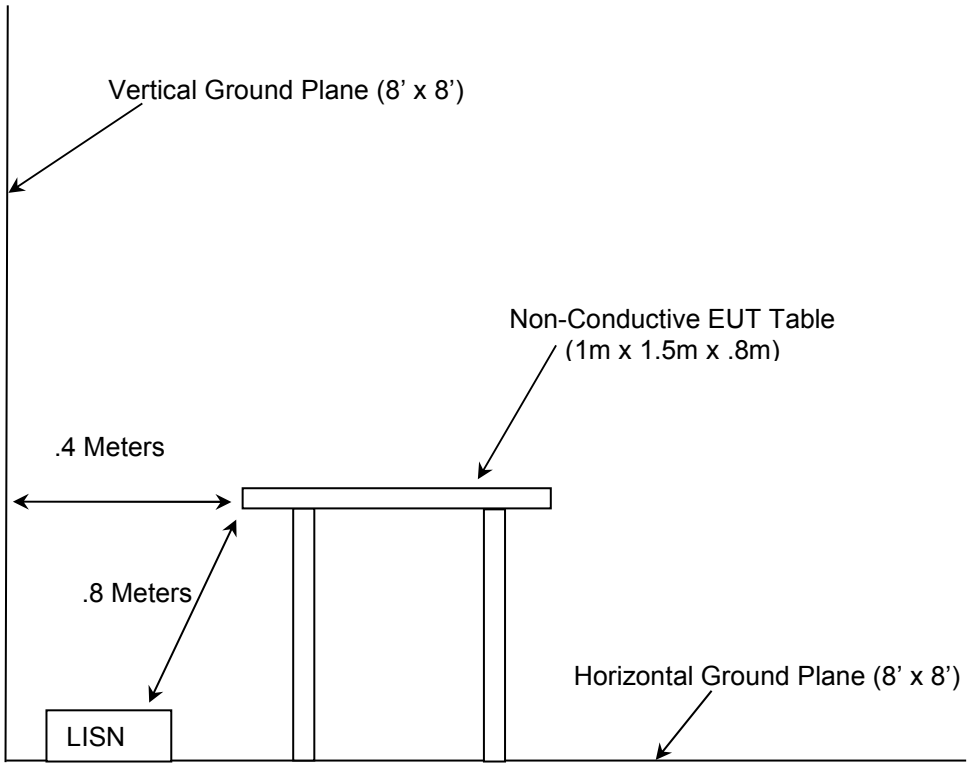

Figure 2.4-1: AC Mains Conducted EMI Site

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
- 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	7/11/2016
2	Rohde & Schwarz	ESMI-Receiver	Spectrum Analyzers	839587/003	7/11/2014	7/11/2016
30	Spectrum Technologies	DRH-0118	Antennas	970102	4/23/2013	5/23/2015
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
168	Hewlett Packard	11947A	Attenuators	44829	1/19/2015	1/19/2016
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
316	Rohde Schwarz	ESH3-Z5	LISN	861189-010	8/15/2013	8/15/2015
324	ACS	Belden	Cables	8214	6/4/2014	6/4/2015
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
RE361	Agilent	AT/E7405A	Analyzers	MY42000089	5/30/2014	5/30/2016

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	V-Infinity	EMSA150120K-P5P-SZ	N/A
3	DC Power Supply	Hewlett Packard	E3630A	KR64308603
4	Isolation Board	Elster	1B12154G02	N/A
5	Electric Utility Meter	Milbank MFG.	Type 3R	N/A

6 EQUIPMENT UNDER TEST SETUP BLOCK DIAGRAM

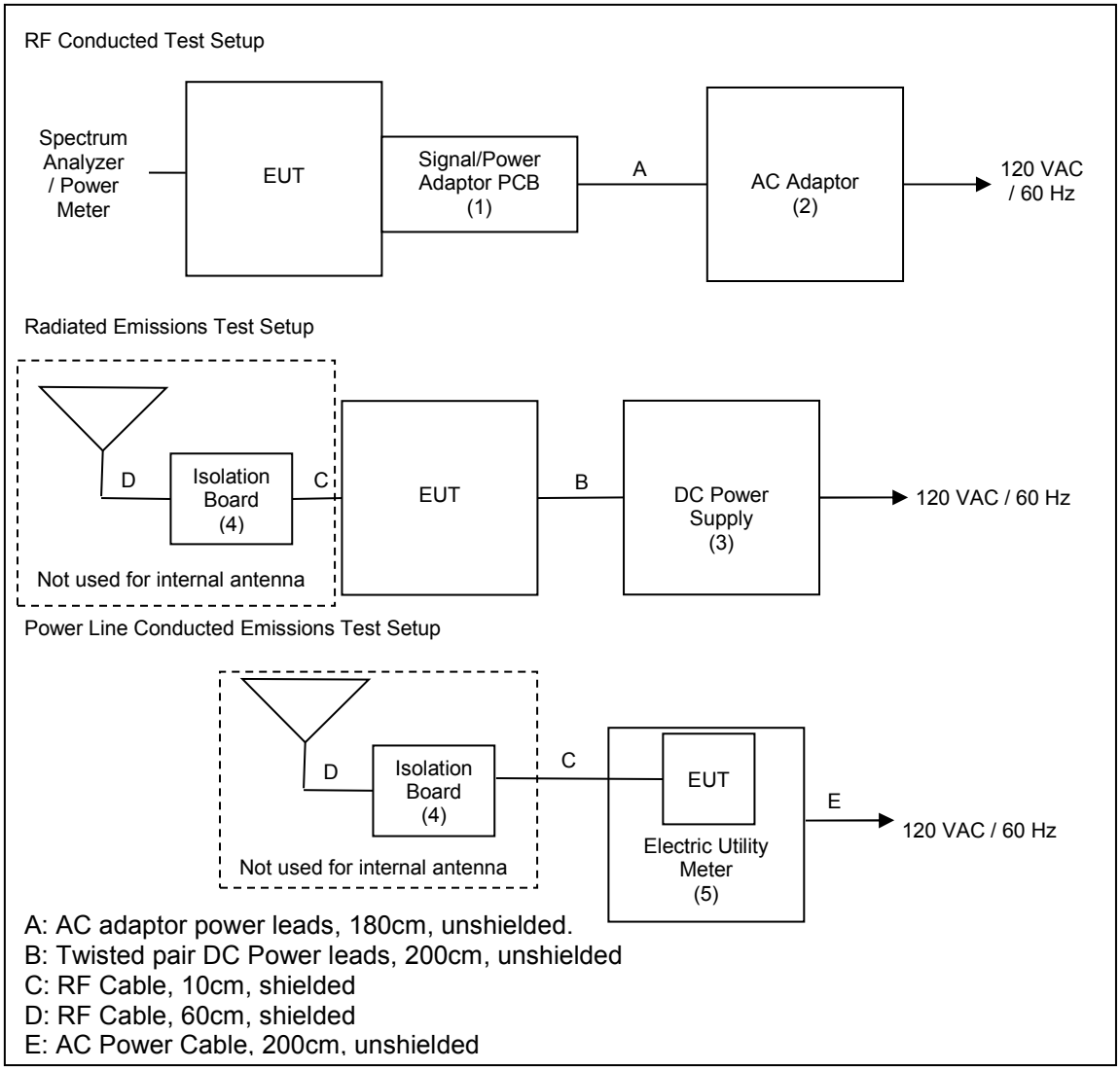

Figure 6-1: Test Setup Block Diagram

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 EUT utilizes an integral PCB trace antenna and a MCX on-board connector for external antennas. The MCX connector is considered unique thus meeting the requirements of Section 15.203.

7.2 Power Line Conducted Emissions – FCC 15.207

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 – Antenna 1

Frequency (MHz)	Uncorrected Reading		Total Correction Factor (dB)	Corrected Level		Limit		Margin (dB)	
	Quasi-Peak	Average		Quasi-Peak	Average	Quasi-Peak	Average	Quasi-Peak	Average
25.8308	10.907	7.384	10.763	21.67	18.147	60	50	38.33	31.853
12.9143	16.774	18.857	10.468	27.242	29.326	60	50	32.758	20.674
8.67518	7.638	9.052	10.388	18.026	19.44	60	50	41.974	30.56
0.51	14.001	4.848	10.31	24.311	15.158	56	46	31.689	30.842
0.499781	13.156	4.631	10.31	23.466	14.941	56.006	46.006	32.541	31.065
0.406969	17.201	5.69	10.31	27.511	16	58.658	48.658	31.147	32.658

Table 7.2.2-2: Conducted EMI Results Line 2 – Antenna 1

Frequency (MHz)	Uncorrected Reading		Total Correction Factor (dB)	Corrected Level		Limit		Margin (dB)	
	Quasi-Peak	Average		Quasi-Peak	Average	Quasi-Peak	Average	Quasi-Peak	Average
12.9006	19.388	22.485	10.468	29.856	32.953	60	50	30.144	17.047
1.07297	12.051	4.012	10.314	22.364	14.325	56	46	33.636	31.675
0.538512	15.863	4.878	10.31	26.173	15.188	56	46	29.827	30.812
0.51515	15.007	4.988	10.31	25.317	15.298	56	46	30.683	30.702
0.508856	14.528	4.727	10.31	24.838	15.037	56	46	31.162	30.963
0.210838	27.825	9.623	10.268	38.093	19.891	64.262	54.262	26.169	34.371

Table 7.2.2-3: Conducted EMI Results Line 1 – Antenna 3

Frequency (MHz)	Uncorrected Reading		Total Correction Factor (dB)	Corrected Level		Limit		Margin (dB)	
	Quasi-Peak	Average		Quasi-Peak	Average	Quasi-Peak	Average	Quasi-Peak	Average
11.4837	10.28	20.268	10.44	20.719	30.708	60	50	39.281	19.292
1.44988	14.463	11.329	10.328	24.791	21.657	56	46	31.209	24.343
0.51625	13.804	4.819	10.31	24.114	15.129	56	46	31.886	30.871
0.333425	23.297	7.645	10.273	33.57	17.918	60.759	50.759	27.189	32.841
0.231363	25.216	8.602	10.264	35.479	18.865	63.675	53.675	28.196	34.81
0.162611	26.892	9.935	10.287	37.179	20.223	65.64	55.64	28.461	35.417

Table 7.2.2-4: Conducted EMI Results Line 2 – Antenna 3

Frequency (MHz)	Uncorrected Reading		Total Correction Factor (dB)	Corrected Level		Limit		Margin (dB)	
	Quasi-Peak	Average		Quasi-Peak	Average	Quasi-Peak	Average	Quasi-Peak	Average
11.469	13.357	23.389	10.439	23.796	33.829	60	50	36.204	16.171
1.45992	9.144	5.562	10.329	19.472	15.89	56	46	36.528	30.11
0.5492	16.077	4.796	10.31	26.387	15.106	56	46	29.613	30.894
0.5238	15.368	4.748	10.31	25.678	15.058	56	46	30.322	30.942
0.5133	14.671	4.808	10.31	24.981	15.118	56	46	31.019	30.882
0.396088	20.681	6.66	10.308	30.988	16.968	58.969	48.969	27.981	32.001

Table 7.2.2-5: Conducted EMI Results Line 1 – Antenna 5

Frequency (MHz)	Uncorrected Reading		Total Correction Factor (dB)	Corrected Level		Limit		Margin (dB)	
	Quasi-Peak	Average		Quasi-Peak	Average	Quasi-Peak	Average	Quasi-Peak	Average
11.4882	7.772	8.273	10.44	18.211	18.713	60	50	41.789	31.287
11.4538	12.049	5.104	10.439	22.488	15.543	60	50	37.512	34.457
1.43316	17.203	20.019	10.328	27.53	30.346	56	46	28.47	15.654
0.559694	15.15	4.807	10.31	25.46	15.117	56	46	30.54	30.883
0.531513	15.092	4.982	10.31	25.402	15.292	56	46	30.598	30.708
0.5127	13.689	4.777	10.31	23.999	15.087	56	46	32.001	30.913

Table 7.2.2-6: Conducted EMI Results Line 2 – Antenna 5

Frequency (MHz)	Uncorrected Reading		Total Correction Factor (dB)	Corrected Level		Limit		Margin (dB)	
	Quasi-Peak	Average		Quasi-Peak	Average	Quasi-Peak	Average	Quasi-Peak	Average
11.3855	11.068	5.036	10.438	21.505	15.474	60	50	38.495	34.526
1.42195	21.596	21.581	10.327	31.923	31.909	56	46	24.077	14.091
0.507949	14.422	4.469	10.31	24.732	14.779	56	46	31.268	31.221
0.473431	11.903	3.951	10.31	22.213	14.261	56.759	46.759	34.546	32.498
0.370299	26.264	8.416	10.292	36.556	18.708	59.706	49.706	23.15	30.998
0.205713	28.23	9.969	10.269	38.499	20.238	64.408	54.408	25.91	34.171

Table 7.2.2-7: Conducted EMI Results Line 1 – Antenna 6

Frequency (MHz)	Uncorrected Reading		Total Correction Factor (dB)	Corrected Level		Limit		Margin (dB)	
	Quasi-Peak	Average		Quasi-Peak	Average	Quasi-Peak	Average	Quasi-Peak	Average
27.1889	12.185	10.871	10.829	23.013	21.7	60	50	36.987	28.3
12.9827	11.811	11.489	10.47	22.28	21.958	60	50	37.72	28.042
1.43121	19.67	18.938	10.328	29.997	29.266	56	46	26.003	16.734
0.503	13.341	4.575	10.31	23.651	14.885	56	46	32.349	31.115
0.25105	21.659	7.392	10.26	31.919	17.652	63.113	53.113	31.194	35.461
0.1735	27.328	9.929	10.279	37.607	20.208	65.329	55.329	27.722	35.121

Table 7.2.2-8: Conducted EMI Results Line 2 – Antenna 6

Frequency (MHz)	Uncorrected Reading		Total Correction Factor (dB)	Corrected Level		Limit		Margin (dB)	
	Quasi-Peak	Average		Quasi-Peak	Average	Quasi-Peak	Average	Quasi-Peak	Average
14.285	13.735	16.344	10.567	24.302	26.911	60	50	35.698	23.089
11.4297	22.305	17.424	10.439	32.743	27.862	60	50	27.257	22.138
1.43922	18.465	17.961	10.328	28.793	28.289	56	46	27.207	17.711
0.51625	14.955	4.759	10.31	25.265	15.069	56	46	30.735	30.931
0.269106	20.25	6.83	10.26	30.51	17.09	62.597	52.597	32.087	35.507
0.180738	27.943	9.964	10.276	38.219	20.241	65.122	55.122	26.903	34.881

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. The device employs < 50 channels at any given time therefore the power is limited to 0.25 Watt.

7.3.2 Measurement Results

Table 7.3.2-1: RF Output Power

Frequency [MHz]	Level [dBm]
902.4	23.35
916.0	23.36
921.6	23.56
927.6	23.98

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. The span of the spectrum analyzer was set wide enough to capture two adjacent peaks. The RBW and VBW were set to 10 kHz and 30 kHz respectively.

7.4.1.2 Measurement Results

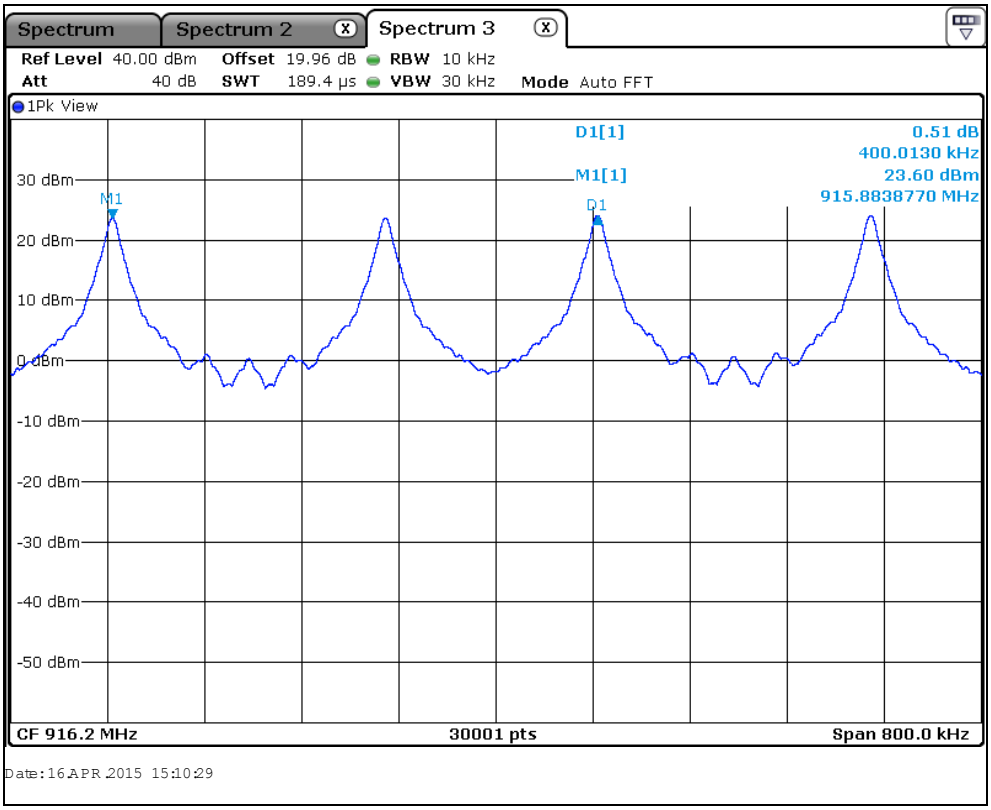

Figure 7.4.1.2-1: Carrier Frequency

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. The span of the spectrum analyzer was set wide enough to capture the frequency band of operation. The RBW was set to 200kHz and VBW set to ≥ RBW.

7.4.2.2 Measurement Results

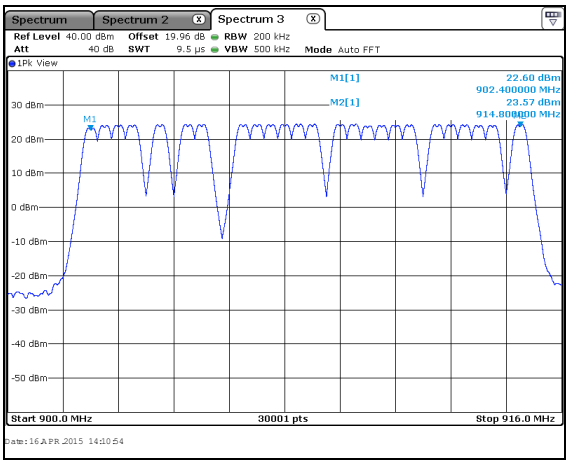

Figure 7.4.2.2-1: Number of Hopping Channels (Low Range)

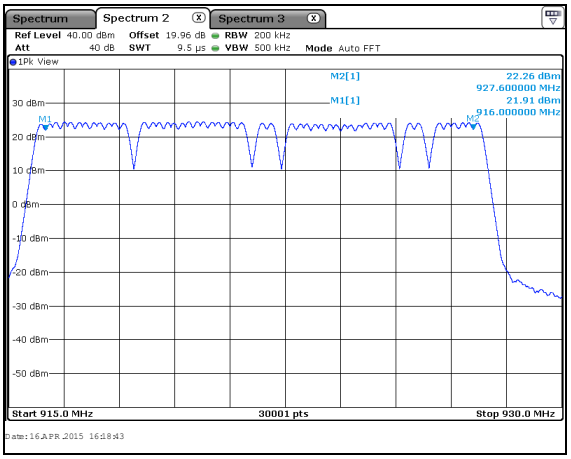

Figure 7.4.2.2-2: Number of Hopping Channels (High Range)

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

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 200ms within a 10s period thus meeting the limit of 400ms for all modes of operation.

7.4.4 20dB / 99% 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. 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 and the n dB down function of the analyzer were 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	311.023	409.220	35.5
916.0	313.956	402.120	35.5
921.6	310.123	431.686	35.5
927.6	311.356	405.153	35.5
902.4	321.056	330.656	142
916.0	321.323	327.656	142
921.6	321.789	335.489	142
927.6	324.489	328.122	142

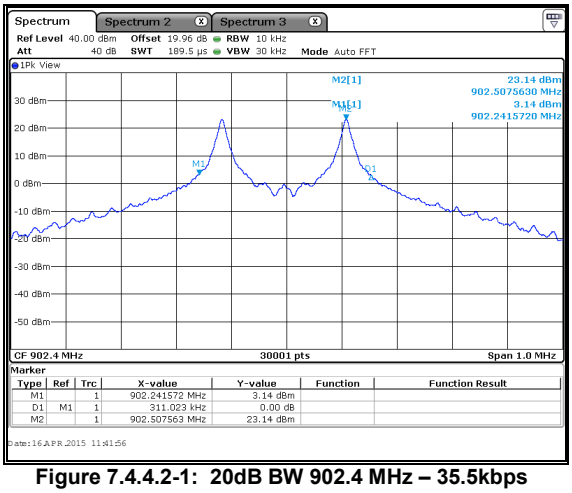

Figure 7.4.4.2-1: 20dB BW 902.4 MHz – 35.5kbps

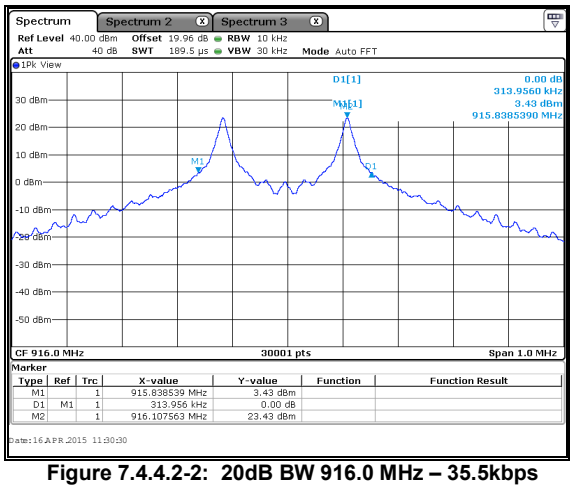

Figure 7.4.4.2-2: 20dB BW 916.0 MHz – 35.5kbps

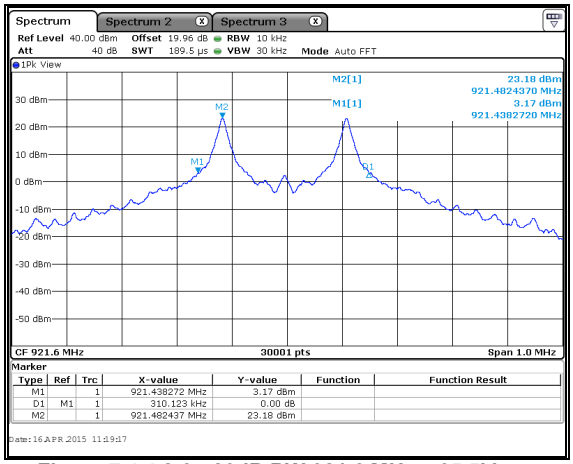

Figure 7.4.4.2-3: 20dB BW 921.6 MHz – 35.5kbps

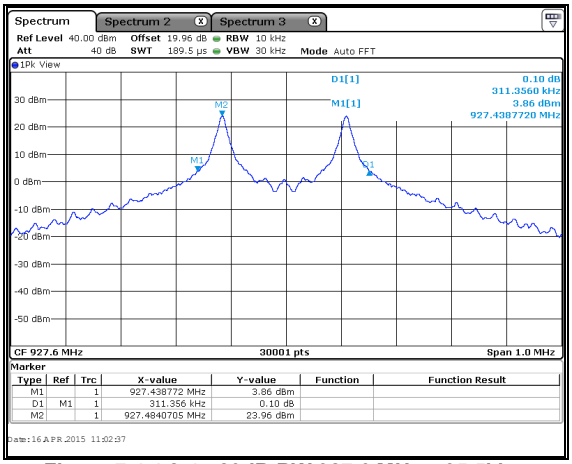

Figure 7.4.4.2-4: 20dB BW 927.6 MHz – 35.5kbps

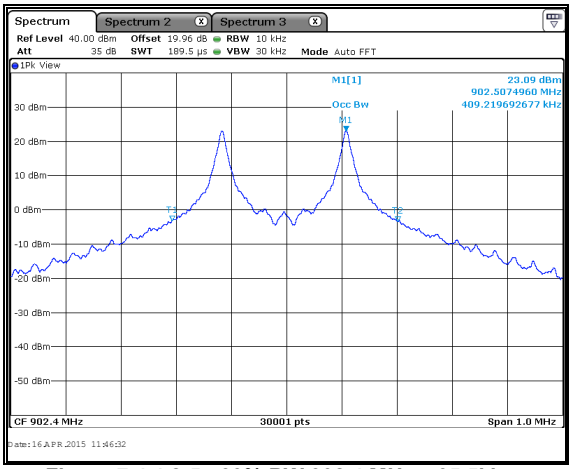

Figure 7.4.4.2-5: 99% BW 902.4 MHz – 35.5kbps

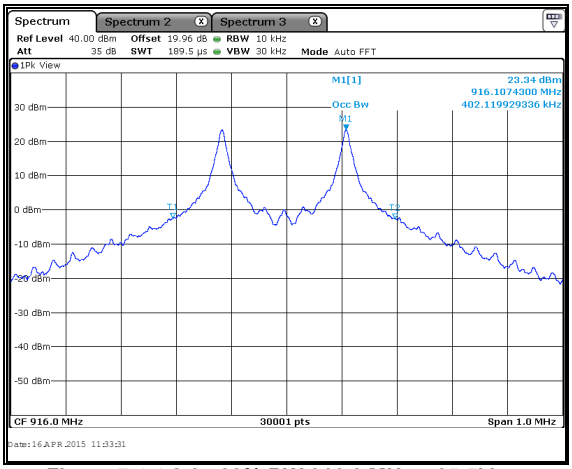

Figure 7.4.4.2.6: 99% BW 916.0 MHz – 35.5kbps

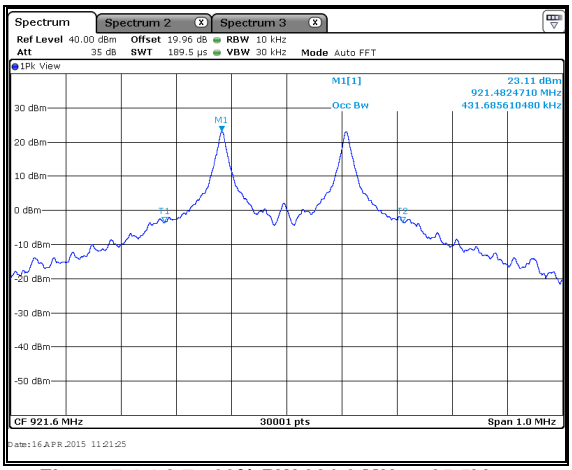

Figure 7.4.4.2.7: 99% BW 921.6 MHz – 35.5kbps

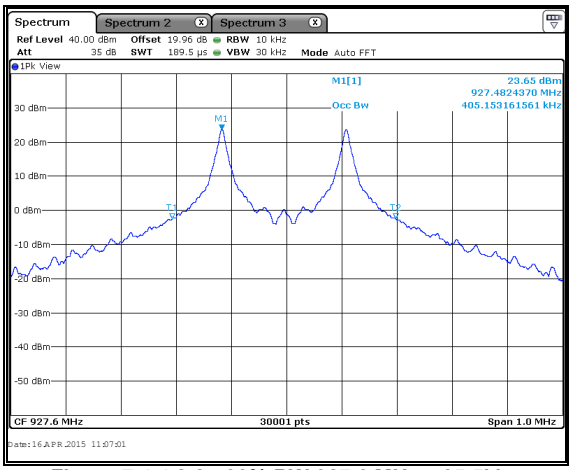

Figure 7.4.4.2-8: 99% BW 927.6 MHz – 35.5kbps

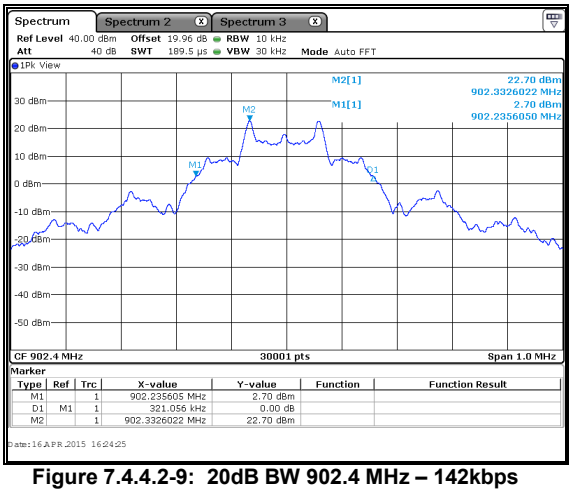

Figure 7.4.4.2-9: 20dB BW 902.4 MHz – 142kbps

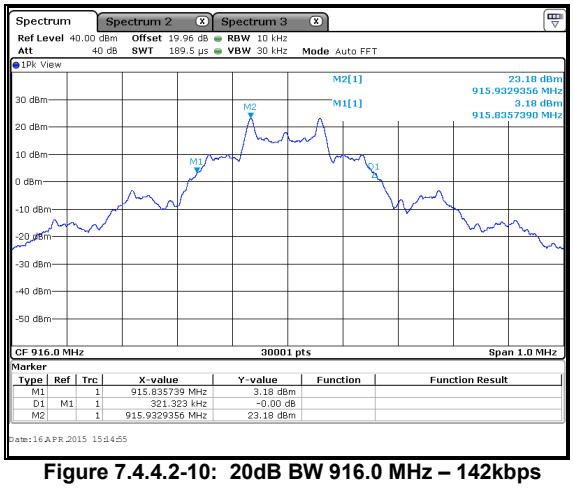

Figure 7.4.4.2-10: 20dB BW 916.0 MHz – 142kbps

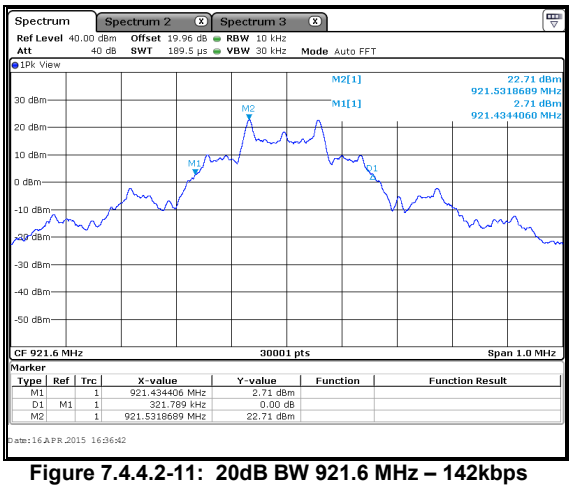

Figure 7.4.4.2-11: 20dB BW 921.6 MHz – 142kbps

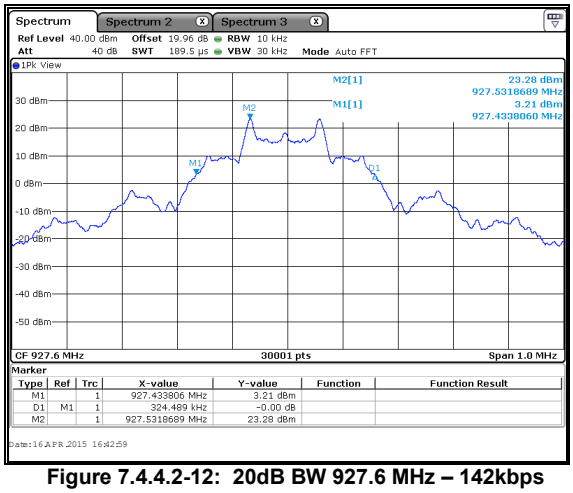

Figure 7.4.4.2-12: 20dB BW 927.6 MHz – 142kbps

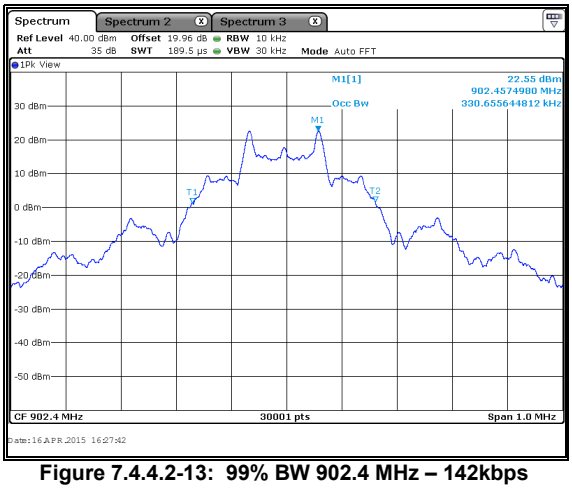

Figure 7.4.4.2-13: 99% BW 902.4 MHz – 142kbps

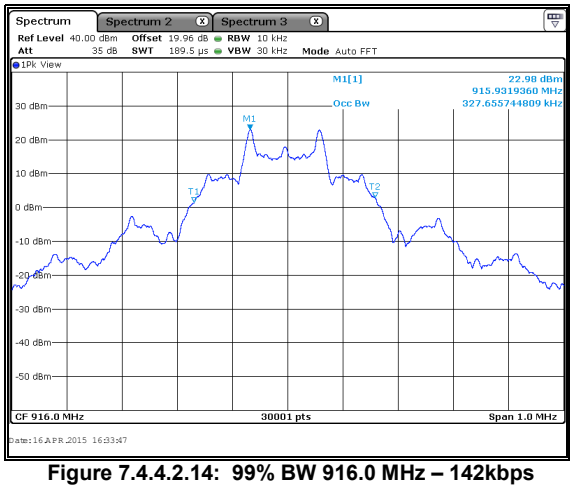

Figure 7.4.4.2.14: 99% BW 916.0 MHz – 142kbps

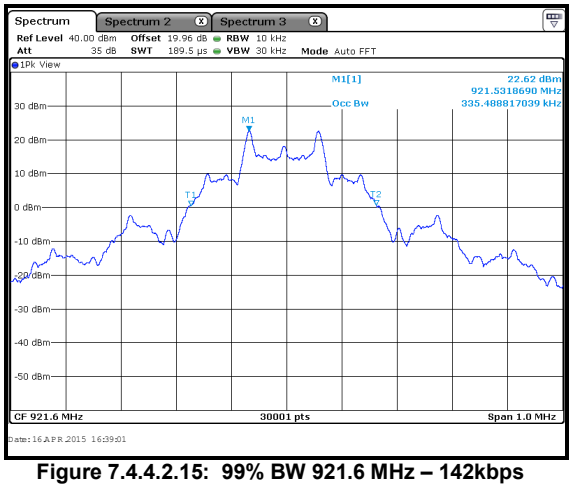

Figure 7.4.4.2.15: 99% BW 921.6 MHz – 142kbps

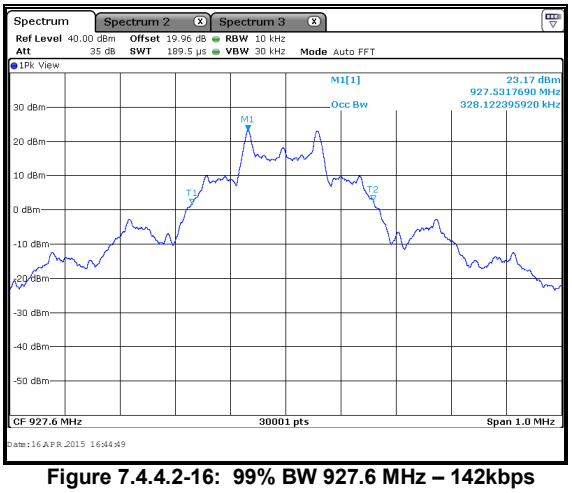

Figure 7.4.4.2-16: 99% BW 927.6 MHz – 142kbps

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. 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:

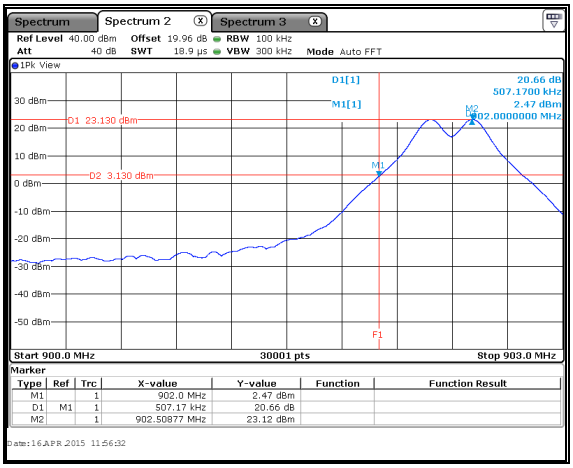

Figure 7.5.1.2-1: Lower Band-edge (Low Range)

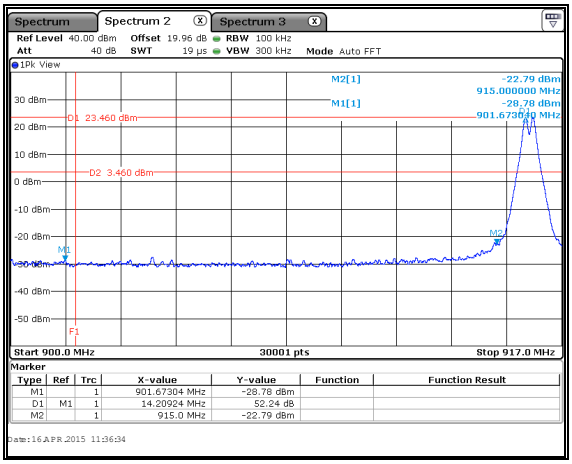

Figure 7.5.1.2-2: Lower Band-edge (High Range)

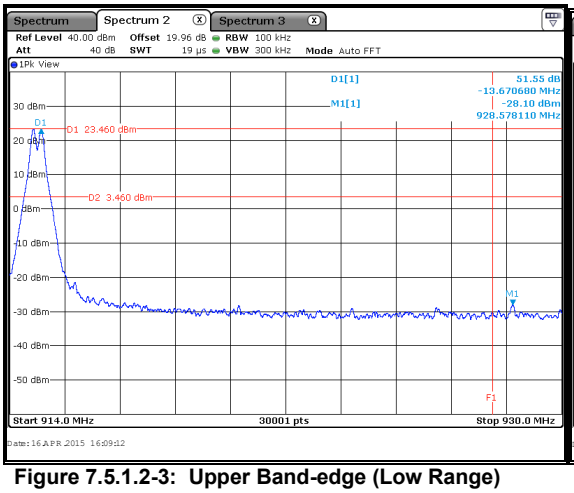

Figure 7.5.1.2-3: Upper Band-edge (Low Range)

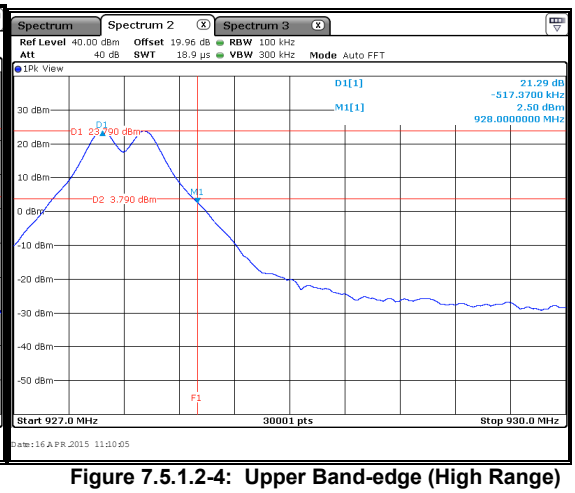

Figure 7.5.1.2-4: Upper Band-edge (High Range)

HOPPING MODE:

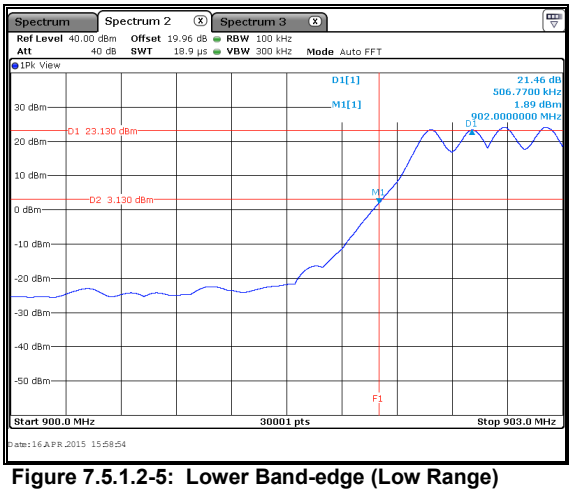

Figure 7.5.1.2-5: Lower Band-edge (Low Range)

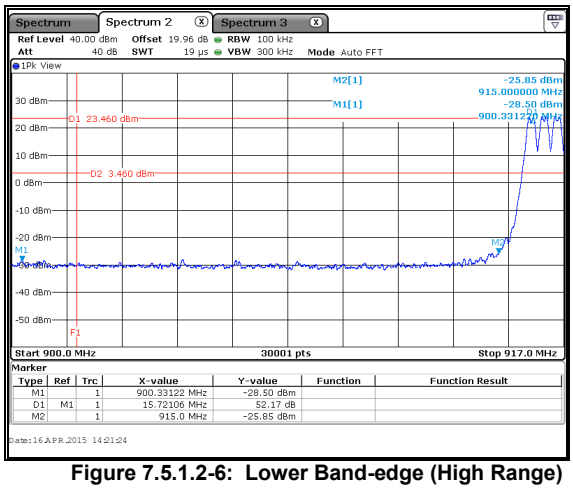

Figure 7.5.1.2-6: Lower Band-edge (High Range)

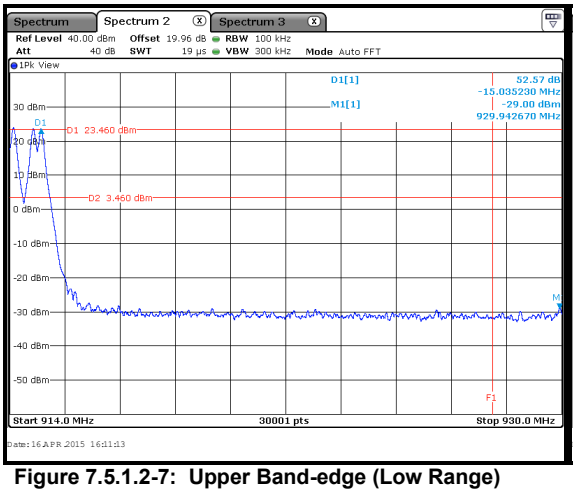

Figure 7.5.1.2-7: Upper Band-edge (Low Range)

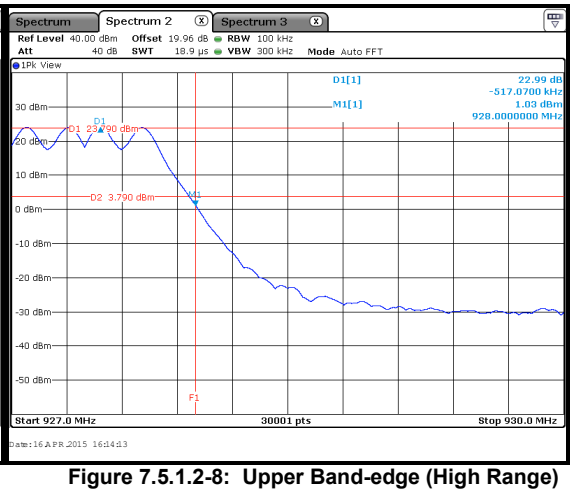

Figure 7.5.1.2-8: Upper Band-edge (High Range)

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. 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

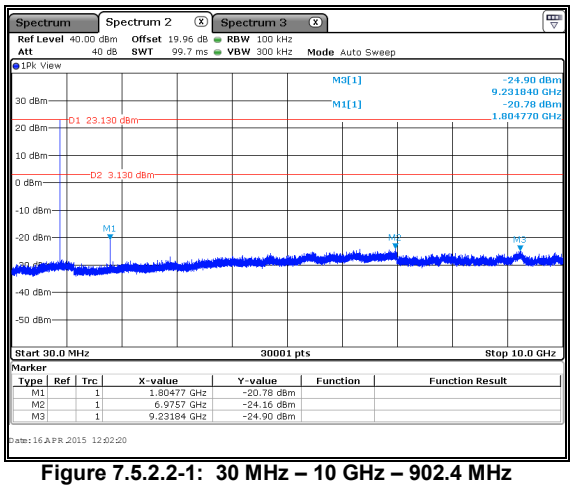

Figure 7.5.2.2-1: 30 MHz – 10 GHz – 902.4 MHz

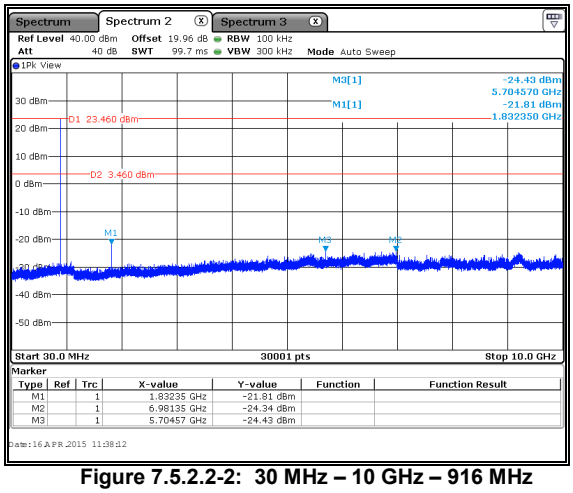

Figure 7.5.2.2-2: 30 MHz – 10 GHz – 916 MHz

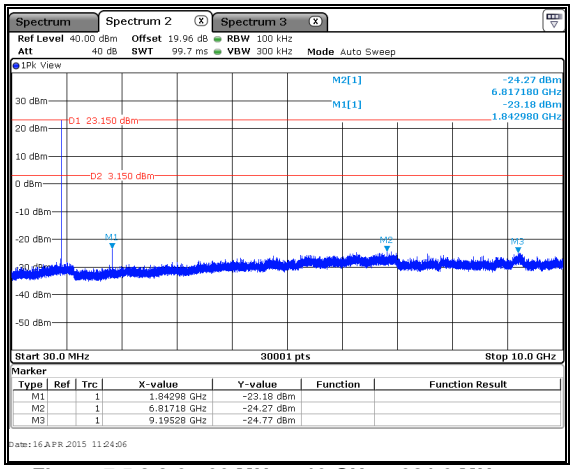

Figure 7.5.2.2-3: 30 MHz – 10 GHz – 921.6 MHz

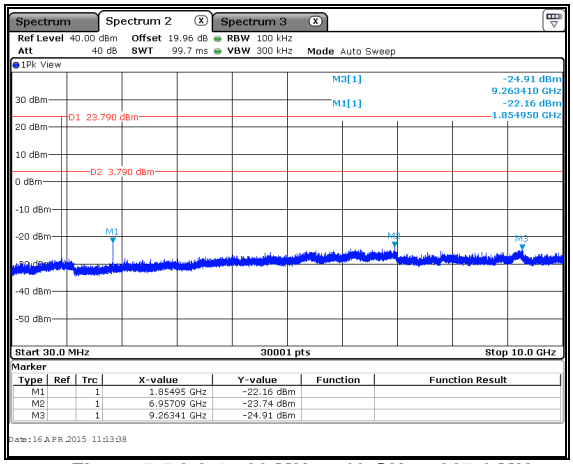

Figure 7.5.2.2-4: 30 MHz – 10 GHz – 927.6 MHz

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.

7.5.3.2 Measurement Results

Table 7.5.3.2-1: Radiated Spurious Emissions Tabulated Data – Antenna 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
902.4 MHz										
All measurements were below the noise floor of the measurement system.										
916.0 MHz										
All measurements were below the noise floor of the measurement system.										
921.6 MHz										
All measurements were below the noise floor of the measurement system.										
927.6 MHz										
All measurements were below the noise floor of the measurement system.										

Table 7.5.3.2-2: Radiated Spurious Emissions Tabulated Data – Antenna 3

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
902.4 MHz										
All measurements were below the noise floor of the measurement system.										
916.0 MHz										
All measurements were below the noise floor of the measurement system.										
921.6 MHz										
All measurements were below the noise floor of the measurement system.										
927.6 MHz										
All measurements were below the noise floor of the measurement system.										

Table 7.5.3.2-3: Radiated Spurious Emissions Tabulated Data – Antenna 5

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
902.4 MHz										
All measurements were below the noise floor of the measurement system.										
916.0 MHz										
All measurements were below the noise floor of the measurement system.										
921.6 MHz										
All measurements were below the noise floor of the measurement system.										
927.6 MHz										
All measurements were below the noise floor of the measurement system.										

Table 7.5.3.2-4: Radiated Spurious Emissions Tabulated Data – Antenna 6

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
902.4 MHz										
All measurements were below the noise floor of the measurement system.										
916.0 MHz										
All measurements were below the noise floor of the measurement system.										
921.6 MHz										
All measurements were below the noise floor of the measurement system.										
927.6 MHz										
All measurements were below the noise floor of the measurement system.										

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

8 CONCLUSION

In the opinion of ACS, Inc. the MRX2EA4, manufactured by Elster Solutions, LLC meets the requirements of FCC Part 15 subpart C.

END REPORT