

1601 North A.W. Grimes Blvd., Suite B Round Rock, TX 78665

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(512) 244-3371 Fax: (512) 244-1846

June 11, 2014

Bandele Adepoju Wireless Seismic, Inc. 13100 Southwest Freeway Suite 150 Sugar Land, TX 77478

Dear Bandele:

Thank you for allowing Professional Testing (EMI), Inc. an opportunity to perform testing for Wireless Seismic, Inc. Enclosed is the Wireless Certification Report for the WRU Model 01-0001. This report can be used to demonstrate compliance with FCC and IC requirements for wireless devices in North America.

Sincerely,

Jeffrey A. Lenk President

Attachment

Project 15298-15

Wireless Seismic, Inc. Wireless Remote Unit (WRU) V4 Model 01-0001

Wireless Certification Report FCC 47 CFR Part 15C IC RSS-210

Prepared for:
Wireless Seismic, Inc.
13100 Southwest Freeway
Suite 150
Sugar Land, TX 77478
By

Professional Testing (EMI), Inc. 1601 North A.W. Grimes Blvd., Suite B Round Rock, Texas 78665

June 11, 2014

Reviewed by

Robert Mc Collough

Robert McCollough Director of Testing Services Written by

Eric Lifsey EMC Engineer

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Revision History

Revision Number	Description	Date
00	Initial draft released	June 11, 2014
01	Revised per client comments.	June 11, 2014
02	Revised per Rob McCollough comments.	June 12, 2014

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NOTICE: (1) This Report must not be used to claim product endorsement, by NVLAP, NIST, the FCC or any other Agency. This report also does not warrant certification by NVLAP or NIST. (2) This report shall not be reproduced except in full, without the written approval of Professional Testing (EMI), Inc. (3) The significance of this report is dependent on the representative character of the test sample submitted for evaluation and the results apply only in reference to the sample tested. The manufacturer must continuously implement the changes shown herein to attain and maintain the required degree of compliance.

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Certificate of Compliance

Applicant	Device & Test Identification				
Wireless Seismic, Inc. (Bandele Adepoju)	FCC ID:	YZO-00106			
13100 Southwest Freeway	Industry Canada ID:	10081A-WSI00106			
Suite 150	Model(s):	01-0001			
Sugar Land, TX 77478	Part Number(s):	10-0029			
Certificate Date: June 11, 2014	Laboratory Project ID:	15298-15			

The Wireless Seismic, Inc., WRU 01-0001 was tested utilizing the following documents and found to be in compliance with the required criteria.

Standard	Reference	Detail
FCC 47 CFR Part 15 C	15.247	Operation within the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz.
FCC 47 CFR Part 15 C	15.209	Radiated emission limits; general requirements.
FCC 47 CFR Part 15 C	15.205	Restricted Bands of Operation
KDB718828	DR01	Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247
KDB412172	D01	Guidelines for Determining the ERP and EIRP of an RF Transmitting System
OET Bulletin 65*	Edition 97-01, and Supplement C, Ed. 01-01	Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields
RSS-210	Issue 8	Licence-exempt Radio Apparatus (All Frequency Bands): Category I Equipment
RSS-Gen	Issue 3	General Requirements and Information for the Certification of Radio Apparatus
RSS-102	Issue 4	Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)

^{*}Exposure is reported separately from this document.

I, Jeffrey A. Lenk, for Professional Testing (EMI), Inc., being familiar with the electromagnetic compatibility rules and test procedures, have reviewed the test setup, measured data, and this report. I believe them to be true and accurate.

Lab Code 200062-0

Jeffrey A. Lenk President

This report has been reviewed and accepted by Wireless Seismic, Inc. The undersigned is responsible for ensuring that the WRU 01-0001 will continue to comply with the applicable rules.

Representative of Wireless Seismic, Inc.

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1 Introduction

1.1 Scope

The purpose of the EMC testing was to determine compliance with FCC and Industry Canada rules. This report describes the extent to which the equipment under test (EUT) conformed to the standards to which it was tested and the manner in which that testing was conducted.

1.2 EUT Description

The EUT is the WRU. The EUT is intended to be used outdoors, commonly remote locations, to measure seismic disturbances (man-made generally) and relay that information by wireless means using the 2.4 GHz band in hopping mode.

The EUT utilizes a type 'HPQN' RF connector for attachment of its antenna. Antennas supplied with the unit are professionally installed by Wireless Seismic, Inc. or its authorized agents.

The system tested consisted of the following:

Table 1.2.1: Equipment Under Test

Manufacturer & Model, EUT:	Serial #	Description				
Wireless Seismic	0120800000150	Remote seismic monitor				
Model 01-0001						
Manufacturer & Model, Attachment(s):						
Comet	None	Fiberglass monopole antenna				
Model CFA-245 (Gain 5.5 dBi max)						
Cords and Cables - None						
Oscillator Frequencies						
16MHz Oscillator, and communicates on rac	lio channels in the rar	nge of 2403 MHz to 2475 MHz.				

1.3 EUT Operation

This device is for outdoor use. It operates as long as charged batteries are connected. Combined with other same or similar units, they are placed at widely-spaced strategic locations on the surface of the soil. Each unit is activated by attaching the external battery packs. They then poll over the air for a collection device designated as the Line Interface Unit (LIU) where they send seismic disturbance measurements. When a seismic event occurs (typically man-made), the device collects the seismic levels and reports the data to the LIU.

The LIU is interfaced to a computer system which collects the seismic data and converts the measurements to a 3-d image of structures beneath the soil surface.

The EUT is powered solely through redundant 3.7 VDC Li-Ion batteries which must be removed to facilitate charging (no provisions for battery charging are integrated into this unit), and as such no mains conducted emissions measurements were required.

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1.4 Modifications to Equipment

No modifications were made to the EUT during the performance of the tests.

1.5 Test Site

Radiated and conducted measurements of emissions were made at Professional Testing Inc. (EMI), Site 45, Austin, Texas, USA.

Measurements of extremes were performed at Professional Testing Inc., 1601 N. A. W. Grimes Blvd., Suite B, Round Rock, Texas, USA.

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2 Peak Output Power, Conducted

2.1 Test Procedure

Power was measured by connection to the EUT using a power attenuator of nominal loss 20 dB and its loss factor was applied. The EUT was connected to the LIU by radiated fields. The EUT was exercised at maximum power at the recorded power setting. Conducted output power measurements were made for the bottom, middle and top channels of the EUT.

2.2 Test Criteria

47 CFR (USA) // IC (Canada)		
Section Reference	Parameter	Date
15.247(a)(3), 15.247(b)(1) //	Fundamental Power Conducted	2014-05-14
RSS-210 Issue 8, A2.9	Limit: 0.125 Watt (21 dBm)	2014-05-14

This device employs 19 hopping channels. Power is limited to 0.125 W per rule for hopping systems employing less than 75 hopping channels.

2.3 Test Results

The emissions from the EUT were measured for the standard 3 channels and are reported below. The power setting level was 15. The 20 dB bandwidth measured just over 3 MHz so resolution and video bandwidth for the power measurement was set to 10 MHz.

The EUT satisfied the limits.

Table 2.3.1 Maximum Peak Output Power, Conducted							
Frequency Measured Power EIRP Limit							
(GHz)	(dBm)	(dBm)					
2.403	19.90	21					
2.440	19.56	21					
2.475	19.14	21					

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2.4 Test Equipment

Asset #	Manufacturer Model #		Description	Calibration Due
ALN-077	Rohde & Schwarz	FSP-30	Spectrum Analyzer	2015-01-29
C248	Pasternack	N/A	Cable	2015-05-14
A105	Narda	768A-20	RF Attenuator, 20 W, 20 dB	2015-05-16
0881	Thermotron	S-1.2C	Environmental Chamber S/N 27131	2014-09-13
None	BK Precision	1710	Bench Power Supply S/N 261 0200 0081	Cal In Use
2087	Fluke	189	DMM, True RMS	2015-03-06

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3 Power Spectral Density, Conducted

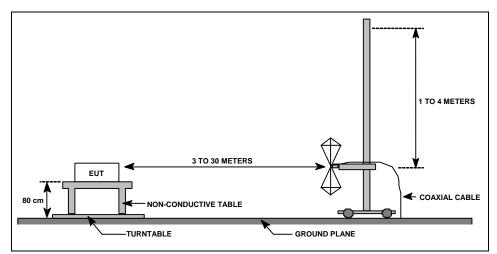
This test is applicable to wide band modulation schemes including direct sequence spread spectrum (DSSS) but not to frequency hopping spread spectrum (FHSS) schemes. This device uses FHSS exclusively. Therefore this test does not apply.

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4 Transmitter/Receiver Unwanted Emissions, Spurious Domain, Radiated

4.1 Test Procedure

The field strength was measured at frequencies from 30 MHz up to 1 GHz at a distance of 10 meters; 1 GHz to 25 GHz at a distance of 3 meters. The EUT was switched on with normal modulation. A diagram showing the test setup is given below.



Spurious Radiated Emissions – Test Setup

The support equipment including the LIU was placed outside of the chamber and communicated with the EUT by an antenna located inside the chamber and approximately 3 meters from the EUT. The antenna was connected by coaxial cable that passed through the chamber sub-floor to the cable feed-through panel. A fixed attenuator was added to the LIU to minimize its signal strength.

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4.2 Test Criteria

47 CFR (USA) // IC (Canada)		
Section Reference	Parameter	Date(s)
15.247, 15.209 //	Field Strength of Radiated	2014 05 12
RSS-Gen Issue 3, 4.9, 4.10	Spurious/Harmonic Emissions	2014-05-13

4.3 Test Results

In the hopping transmit/receive mode, emissions were measured from 30 MHz to 25 GHz.

In the non-hopping single-channel mode, emissions were measured in transmit/receive mode from 1 GHz to 25 GHz. Three channels were selected; lowest, middle, and highest.

The radiated emissions generated by the EUT were below the applicable limits.

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Wireless Seismic, Inc. - WRU 01-0001 - Certification/EMC Report Table 4.3.1: Vertical, Spurious Radiated Emissions – T/R, Hopping, Below 1 GHz

			Profes	sional Te	sting, El	VII, Inc.			
Test Metho	od:			ds of Measurer e Range of 9 kH				_	
In accorda	nce with:	Limits	209 - Code of	Federal Regulat	ions Part 47, S	Subpart C - Int	entional Rad	diators, Radiat	ed Emissions
Section:		15.209			1		,		
Test Date(s):	5/13/2014			EUT Serial		12080000	0150	
Customer:		Wireless Se	eismic		EUT Part #:		N/A		
Project Nu		15298-15			Test Techn		Larry Full		
Purchase C		C' - I - Ol			Supervisor		Rob McCc		
Equip. Und	ier rest:	Single-Cha	nnel Wirele	ss kemote	Witness' N	ame:	Bandele A	aepoju	
			nissions Tes	t Results Data	Sheet			age: 1	of 1
EUT L	ine Voltage	: 3	.7 VDC		EUT Pow	ver Frequen	cy:	N/A N/A	
Antenna Orientation: V				al	Frequ	ency Range		30MHz to	1GHz
	EUT N	/lode of Op	eration:			Transmitt	ing/receivi	ng hopping	
Frequency Measured (MHz)	Test Distance (Meters)	EUT Direction (Degrees)	Antenna Height (Meters)	Detector Function	Recorded Amplitude (dBµV)	Corrected Level (dBµV/m)	Limit Leve (dBµV/m)		Test Results
35.5719	10	251	1.53	Quasi-peak	23.5	9.424	29.5	-20.1	Pass
60.0082	10	181	3.17	Quasi-peak	35.3	13.952	29.5	-15.5	Pass
70.2244	10	29	1.76	Quasi-peak	34.1	12.689	29.5	-16.8	Pass
72.6141	10	144	2.18	Quasi-peak	30.9	9.312	29.5	-20.2	Pass
746.84	10	285	1.62	Quasi-peak	21.7	18.475	35.6	-17.1	Pass
981.598	10	41	2.83	Quasi-peak	21.1	21.921	43.5	-21.6	Pass
60	essional Te ed Emissions, - 1 GHz Vertical	sting, EMI, 10m Distance Polarity Measure	Inc d Emissions				Corrected Q Corrected Po LIM X Peak LIM X QP	eak Valu	SSIONAL , , , N 6
(m/A m/d 94) 40 40 40 40 40 40 40 40 40 40 40 40 40									
Field Streng		lange lange					and to deliver the state of the	The state of the s	7
Ξ 10			Y A PARTY OF THE P	Marin Ma	Maria de la compansión de				
0 10 M				1.0	0 M				1 G

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			Profes	sional Te	sting, El	MI, Inc.			
Test Meth	od:		2003: "Metho	ods of Measurer e Range of 9 kH	ment of Radio	-Noise Emissio		_	
n accordance with: FCC Part 15.209 - Code of Federal Regulations Part 47, Subpart C - Intention								iators, Radiat	ed Emissions
Section:		15.209					_		
Test Date(s):	5/13/2014			EUT Serial	#:	120800000	150	
Customer:		Wireless S	eismic		EUT Part #:		N/A		
Project Nu		15298-15			Test Techn		Larry Fulle		
Purchase (Supervisor		Rob McCo		
Equip. Und	ler Test:	Single-Cha	nnel Wirele	ss Remote	Witness' N	ame:	Bandele A	depoju	
	F	Radiated Er	nissions Test	t Results Data	a Sheet		Ра	ge: 1	of 1
EUT L	ine Voltage	: 3	3.7 VDC		EUT Pow	ver Frequen	cy: N	/A N/A	
Antenn	a Orientatio	on:	Horizo	ntal	Frequ	ency Range		30MHz to	1GHz
	EUT N	/lode of Op	eration:			Transmitt	ing/receivir	ng hopping	
Frequency Measured (MHz)	Test Distance (Meters)	EUT Direction (Degrees)	Antenna Height (Meters)	Detector Function	Recorded Amplitude (dBμV)	Corrected Level (dBµV/m)	Limit Level (dBµV/m)	Margin (dB)	Test Results
34.7428	10	22	2.27	Quasi-peak	23	9.426	29.5	-20.1	Pass
38.1433	10	107	2.44	Quasi-peak	23.7	8.221	29.5	-21.3	Pass
39.4317	10	296	1.39	Quasi-peak	24	7.796	29.5	-21.7	Pass
48.6317	10	127	3.18	Quasi-peak	23.7	3.984	29.5	-25.5	Pass
846.971	10	297	1.08	Quasi-peak	21.4	19.728	35.6	-15.9	Pass
954.243	10	65	2.8	Quasi-peak	21.1	21.377	35.6	-14.2	Pass
30MHz	essional Tested Emissions, - 1 GHz Horizon	sting, EMI 10m Distance talPolarity Mea	, Inc				Corrected Qu Corrected Pe LIM X Peak LIM_X_QP_A	ak Valu	SSIONAL 1 N 6
Field Strength (dB V/m) 30 20 20 20 20 20 20 20 20 20 20 20 20 20			~						
10 0 10 M				10 Freode: Transmitting/	0 M		EUT: Single-Cha	nnel Wireless Re	1G mote Unit (WR U

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			Profess	sional Te	sting, EN	MI, Inc.				
Test Metho	od:			ds of Measurer e Range of 9 kH				·		l
In accorda	nce with:	FCC Part 15.2 Limits	09 - Code of F	ederal Regulat	tions Part 47, S	Subpart C - Int	entional Radi	ators, Radiat	ed Emiss	ions
Section:		15.209								
Test Date(s	s):	5/13/2014			EUT Serial	#:	120800000	150		
Customer:		Wireless Se	ismic		EUT Part #:		N/A			
Project Nu	mber:	15298-15			Test Techni	ician:	Larry Fulle	r		
Purchase C	Order #:				Supervisor:		Rob McCol	lough		
Equip. Und	ler Test:	Single-Char	nel Wireles	s Remote	Witness' Na	ame:	Bandele A	depoju		
	F	Radiated Em	issions Test	Results Data	a Sheet		Pa	ge: 1	of	1
EUT L	ine Voltage:	: 3.	7 VDC		EUT Pow	er Frequen	cy: N	/A N/A		
Antenn	a Orientatio	n:	Vertic	al	Freque	ency Range:		Above 1	GHz	
	EUT N	lode of Ope	ration:			Transmitt	ing/receivir	ng hopping		
Frequency Measured (MHz)	Test Distance (Meters)	EUT Direction (Degrees)	Antenna Height (Meters)	Detector Function	Recorded Amplitude (dBµV)	Corrected Level (dBµV/m)	Limit Level (dBµV/m)	Margin (dB)	Test R	esults
1165.33	3	79	0	Average	35.1	22.39	54.0	-31.6	Pa	SS
2220.32	3	187	0	Average	34.5	25.456	54.0	-28.5	Pa	SS
3129.86	3	258	0	Average	34.9	27.416	54.0	-26.5	Pa	SS
4307.27	3	212	0	Average	33.6	28.39	54.0	-25.6	Pa	ss
5297.22	3	315	0	Average	32.4	29.018	54.0	-24.9	Pa	SS
5991.18	3	179	0	Average	31.2	30.849	54.0	-23.1	Pa	SS
7732.76	3	64	0	Average	27.8	34.29	54.0	-19.7	Pa	SS
8598.49	3	283	0	Average	27.7	35.858	54.0	-18.1	Pa	SS
11519.7	3	279	0	Average	27.5	38.706	54.0	-15.3	Pa	SS
12819.2	3	131	0	Average	28	39.032	54.0	-14.9	Pa	SS
16624.3	3	153	0	Average	27.6	43.48	54.0	-10.5	Pa	SS
1-18 GB 90 80 80 80 70 80 80 80 80 80 80 80 80 80 80 80 80 80	2.0G 3.0G	sting, EMI, 3m Distance y Measured Emis	6.0 G 7.0 G	8.0G 9.0G de: Transmitting/		12.0G 13.00	EUT: Single-Cha	G 16.0G 17		
-	or: Larry Fuller 5-13 Run01 M	HzGHzHop1.til	EUT Po	wer: 3.7 VDc	receiving no hhim		Project Number: Client: Wireless S			

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			Profes	sional Te	sting, EN	MI, Inc.			
Test Metho	d:			ds of Measurer e Range of 9 kH				_	
In accordan	ice with:	FCC Part 15.2 Limits	209 - Code of	Federal Regulat	tions Part 47, S	Subpart C - Int	tentional Radi	ators, Radiate	ed Emissions
Section:		15.209							
Test Date(s):	5/13/2014			EUT Serial	# :	120800000	150	
Customer:	ıstomer: Wireless Seismic EUT Part #: N/A								
Project Nur	nber:	15298-15			Test Techni	ician:	Larry Fulle		
Purchase O	rder #:				Supervisor:		Rob McCol	lough	
Equip. Und	er Test:	Single-Char	nnel Wirele	ss Remote	Witness' N	ame:	Bandele A	depoju	
	F	Radiated Em	issions Test	Results Data	a Sheet		Pa	ge: 1	of 1
EUT Li	ne Voltage	: 3	.7 VDC		EUT Pow	ver Frequen	cy: N	/A N/A	
Antenna	Orientation	n:	Horizor	ntal	Frequ	ency Range		Above 1	GHz
EUT Mode of Operation: Transmitting/receiving hopping									
Frequency Measured (MHz)	Test Distance (Meters)	EUT Direction (Degrees)	Antenna Height (Meters)	Detector Function	Recorded Amplitude (dBµV)	Corrected Level (dBµV/m)	Limit Level (dBµV/m)	Margin (dB)	Test Result
1170.47	3	259	0	Average	35.1	22.366	54.0	-31.6	Pass
2221.22	3	9	0	Average	34.5	25.473	54.0	-28.5	Pass
3127.69	3	281	0	Average	34.7	27.278	54.0	-26.7	Pass
4297.95	3	258	0	Average	33.6	28.405	54.0	-25.6	Pass
5296.39	3	136	0	Average	32.5	29.086	54.0	-24.9	Pass
5985.19	3	26	0	Average	31.3	30.913	54.0	-23.0	Pass
7738.77	3	76	0	Average	27.6	34.18	54.0	-19.8	Pass
8598.29	3	245	0	Average	27.6	35.749	54.0	-18.2	Pass
11503.6	3	322	0	Average	27.5	38.761	54.0	-15.2	Pass
12817.5	3	75	0	Average	27.9	38.988	54.0	-15.0	Pass
16629.7	3	144	0	Average	27.6	43.479	54.0	-10.5	Pass
Professional Testing, EMI, Inc Radiated Emissions, 3m Distance 1-18GHz Horizontal Polarity Measured Emissions 90 80 70 40 30 70 70 70 70 70 70 70 70 70 70 70 70 70									
	2.0G 3.0G r: Larry Fuller 5-13_Run01_M	4.0 G 5.0 G	6.0G 7.0G EUTMEUTPO	8.0G 9.0G Free ode: Transmitting/ wer: 3.7 VDc		;]	G 14.0 G 15.0 EUT: Sing le-Cha Project Number: Client: Wireless S	nnel Wireless Rei 15298-15	HILLING OG 18.0G mote Unit (WR U

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> 1GHz Horizontal Antenna Polarity Measured Emissions

Purchase Order #: Single-Channel Wireless Remote Witness' Name: Bandele Adepoju Bandele Ade				Profess	sional Te	sting, EN	VII, Inc.				
Limits 15.209	Test Metho	d:							_		ı
EUT Serial #: 120800000150	In accordar	ice with:		09 - Code of F	ederal Regulat	ions Part 47, S	Subpart C - Int	entional Rad	iators, Radiato	ed Emiss	ions
Customer: Wireless Seismic EUT Part #: N/A	Section:		15.209								
Project Number: 15298-15 Test Technician: Larry Fuller Supervisor: Rob McCollough Equip. Under Test: Single-Channel Wireless Remote Witness' Name: Bandele Adepoju Fandle A	Test Date(s):	5/13/2014			EUT Serial	# :	120800000	150		
Page	Customer:		Wireless Se	ismic		EUT Part #:		N/A			
Radiated Emissions Test Results Data Sheet Page: 1 of 1	· · · · · · · · · · · · · · · · · · ·										
Radiated Emissions Test Results Data Sheet Page: 1 of 1	Purchase Order #: Supervisor: Rob McCollough										
Frequency Test Distance (MHz) Distance (MHz) (Meters) (Meter	Equip. Under Test: Single-Channel Wireless Remote Witness' Name: Bandele Adepoju										
Rate Prequency Test BUT Direction Direction (Meters) Distance (Meters) Direction Direction (Meters) Direction D		F	Radiated Em	issions Test	Results Data	Sheet		Pa	age: 1	of	1
Transmitting/receiving Low Channel				7 VDC							
Test Distance (Meters) Direction (Direction (Meters) Direction	Antenna	Orientatio	n:	Vertic	al	Frequ	ency Range:		Above 1	GHz	
Measured (MHz)	EUT Mode of Operation: Transmitting/receiving Low Channel										
2223.69 3 40 1 Average 34.5 25.487 54.0 -28.5 Pass 3125.55 3 280 1 Average 34.9 27.406 54.0 -26.6 Pass 4292.59 3 206 1 Average 33.6 28.392 54.0 -25.6 Pass 5288.08 3 75 1 Average 32.4 28.987 54.0 -25.0 Pass 598.25 3 85 1 Average 31.3 30.896 54.0 -23.1 Pass 7749.69 3 34.0 1 Average 27.8 34.437 54.0 -19.5 Pass 8592.38 3 314 1 Average 27.8 35.958 54.0 -18.0 Pass 11512.7 3 218 1 Average 27.5 38.703 54.0 -15.3 Pass 12812.1 3 345 1 Average 28 39.025 54.0 -14.9 Pass 16612.5 3 99 1 Average 27.6 43.455 54.0 -10.5 Pass Professional Testing, EMI, Inc Radiated Emissions 3 Distance 1-BCILZ Vertical Polarity Measured Emissions	Measured	Distance	Direction	Height		Amplitude	Level			Test R	esult
3125.55 3 280 1 Average 34.9 27.406 54.0 -26.6 Pass 4292.59 3 206 1 Average 33.6 28.392 54.0 -25.6 Pass 5288.08 3 75 1 Average 32.4 28.987 54.0 -25.0 Pass 5988.25 3 85 1 Average 31.3 30.896 54.0 -23.1 Pass 7749.69 3 340 1 Average 27.8 34.437 54.0 -19.5 Pass 8592.38 3 314 1 Average 27.8 35.958 54.0 -18.0 Pass 11512.7 3 218 1 Average 27.5 38.703 54.0 -15.3 Pass 12812.1 3 345 1 Average 28 39.025 54.0 -14.9 Pass 16612.5 3 99 1 Average 27.6 43.455 54.0 -10.5 Pass Professional Testing, EMI, Inc Radiated Emissions 3m Distance 1-18 GHz Vertical Polarity Measured Emissions 3m Distance 1-18 GHz Vert	1162.44		4	1	Average	35.2	22.378	54.0	-31.6	Pa	SS
4292.59 3 206 1 Average 33.6 28.392 54.0 -25.6 Pass 5288.08 3 75 1 Average 32.4 28.987 54.0 -25.0 Pass 5988.25 3 85 1 Average 31.3 30.896 54.0 -23.1 Pass 7749.69 3 340 1 Average 27.8 34.437 54.0 -19.5 Pass 8592.38 3 314 1 Average 27.8 35.958 54.0 -18.0 Pass 11512.7 3 218 1 Average 27.5 38.703 54.0 -15.3 Pass 12812.1 3 345 1 Average 28 39.025 54.0 -14.9 Pass 16612.5 3 99 1 Average 27.6 43.455 54.0 -10.5 Pass Professional Testing, EMI, Inc Rusidated Emissions 3m Distance Ling Ling Level Corrected Peak Reading Professional Testing, EMI, Inc Rusidated Emissions 3m Distance Ling Ling Level Corrected Peak Reading Professional Testing, EMI, Inc Rusidated Emissions 3m Distance Ling Ling Level Corrected Peak Reading Professional Testing, EMI, Inc Rusidated Emissions 3m Distance Ling Ling Ling Ling Ling Ling Ling Ling	2223.69	3	40	1	Average	34.5	25.487	54.0	-28.5	Pa	SS
See No. 3	3125.55	3	280	1	Average	34.9	27.406	54.0	-26.6	Pa	SS
System	4292.59	3	206	1	Average	33.6	28.392	54.0	-25.6	Pa	SS
7749.69 3 340 1 Average 27.8 34.437 54.0 -19.5 Pass 8592.38 3 314 1 Average 27.8 35.958 54.0 -18.0 Pass 11512.7 3 218 1 Average 27.5 38.703 54.0 -15.3 Pass 12812.1 3 345 1 Average 28 39.025 54.0 -14.9 Pass 16612.5 3 99 1 Average 27.6 43.455 54.0 -10.5 Pass Professional Testing, EMI, Inc Radiated Emissions 3m Distance 1-18GHz Vertical Polarity Measured Emissions 3m Distance 1-18GHz Vertical	5288.08		75	1	Average	32.4	28.987	54.0	-25.0	Pa	SS
8592.38 3 314 1 Average 27.8 35.958 54.0 -18.0 Pass 11512.7 3 218 1 Average 27.5 38.703 54.0 -15.3 Pass 12812.1 3 345 1 Average 28 39.025 54.0 -14.9 Pass 16612.5 3 99 1 Average 27.6 43.455 54.0 -10.5 Pass Professional Testing, EMI, Inc Radiated Emissions 3m Distance 1-18GHz Vertical Polarity Measured Emissions 90 From 1 Average 1 Average Limit Level Corrected Peak Reading Professional Testing and the second professional Te	5988.25			1	Average	31.3	30.896	54.0	-23.1	Pa	SS
11512.7 3 218 1 Average 27.5 38.703 54.0 -15.3 Pass 12812.1 3 345 1 Average 28 39.025 54.0 -14.9 Pass 16612.5 3 99 1 Average 27.6 43.455 54.0 -10.5 Pass Professional Testing, EMI, Inc Radiated Emissions, 3m Distance 1-18GHz Vertical Polarity Measured Emissions Polarity Measured Emi			340		Average	27.8	34.437	54.0	-19.5		
12812.1 3 345 1 Average 28 39.025 54.0 -14.9 Pass 16612.5 3 99 1 Average 27.6 43.455 54.0 -10.5 Pass Professional Testing, EMI, Inc Radiated Emissions, 3m Distance 1-18GHz Vertical Polarity Measured Emissions Peak Limit Level Corrected Peak Reading Peak Limit Level Corrected Peak Read			314		Average	27.8	35.958	54.0	-18.0		
Professional Testing, EMI, Inc Radiated Emissions, 3m Distance 1-18GHz Vertical Polarity Measured Emissions Average Limit Level Corrected Average Reading					Average				+		
Professional Testing, EMI, Inc Radiated Emissions, 3m Distance 1-ISCHz Vertical Polarity Measured Emissions 90 80 80 80 90 90 90 90 90 90 90 90 90 90 90 90 90							,		+	Pa	SS
Radiated Emissions, 3m Distance 1-18GHz Vertical Polarity Measured Emissions 90 80 70 40 40 30 40 40 40 40 40 40 40 40 40 40 40 40 40	16612.5	3	99	1	Average	27.6	43.455	54.0	-10.5	Pa	SS
Operator: Larry Fuller Frequency EUT: Single-Channel Wireless Remote Unit (WRU) M	1-18GHz 90 80 80 80 80 90 90 90 90 90 90 90 90 90 90 90 90 90	Vertical Polarity		Y	Fred	V V	∨ Con — Per — Con	rrected Average ak Limit Level crected Peak Rea	ding PROFESS	18G	

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Frequency Measured (MHz) Test Distance (Meters) EUT Direction (Degrees) Antenna Height (Meters) Detector Function Recorded Amplitude (dBμV) Complete (dBμV) 1152.08 3 246 1 Average 35.1 26.2 2209.12 3 61 1 Average 34.5 22.3 3130.53 3 311 1 Average 34.9 2.2 4302.59 3 10 1 Average 33.5 2.2 5289.69 3 48 1 Average 32.5 2.2 5981.66 3 100 1 Average 31.3 3. 7732.85 3 14 1 Average 27.6 3. 8600.09 3 28 1 Average 27.7 3. 11510.4 3 318 1 Average 27.5 3. 12809.7 3 180 1 Average 27.9 3.	12080 N/A In: Larry Rob N Ie: Bando	rence, see §15.38 al Radiators, Radiat 00000150 Fuller //cCollough ele Adepoju Page: 1 N/A N/A Above 1 ving Low Chanr Level Margin //m) (dB) .0 -31.7 .0 -28.5 .0 -26.6 .0 -25.7 .0 -24.9	of 1 LGHz Pass Pass Pass Pass Pass Pass Pass	
In accordance with: Limits Section: 15.209 Test Date(s): 5/13/2014 Customer: Wireless Seismic EUT Part #: Project Number: 15298-15 Purchase Order #: Equip. Under Test: Single-Channel Wireless Remote Radiated Emissions Test Results Data Sheet EUT Line Voltage: 3.7 VDC EUT Power I Antenna Orientation: Horizontal Frequency EUT Mode of Operation: Tran Frequency Test EUT Antenna Measured (MHz) (Meters) (Degrees) (Meters) I152.08 3 246 1 Average 35.1 2209.12 3 61 1 Average 34.9 2209.12 3 61 1 Average 34.9 24032.59 3 10 1 Average 33.5 2400.59 3 10 1 Average 32.5 2209.12 3 61 1 Average 32.5 2209.12 3 61 1 Average 33.5 240.59 3 10 1 Average 32.5 2209.12 3 61 1 Aver	12080 N/A	Fuller //cCollough ele Adepoju Page: 1 N/A N/A Above 1 ving Low Chann Level Margin //m) (dB) .0 -31.7 .0 -28.5 .0 -26.6 .0 -25.7 .0 -24.9	of 1 LGHz rel Pass Pass Pass Pass Pass Pass Pass Pass	
Test Date(s): 5/13/2014 EUT Serial #:	Frequency: cy Range: nsmitting/recei level Level (dBµV/m) 22.28 54 25.485 54 27.377 54 28.266 54	Fuller //cCollough ele Adepoju Page: 1 N/A N/A Above 1 ving Low Chann Level Margin (dB) .0 -31.7 .0 -28.5 .0 -26.6 .0 -25.7 .0 -24.9	Test Results Pass Pass Pass Pass Pass Pass Pass	
Customer: Wireless Seismic Forject Number: 15298-15 Test Technician Supervisor: Supervisor: Supervisor: Fequip. Under Test: Single-Channel Wireless Remote Witness' Name Radiated Emissions Test Results Data Sheet EUT Line Voltage: 3.7 VDC EUT Power I Frequency Antenna Orientation: Horizontal Frequency Measured Distance (MHz) (Degrees) (Meters) Detector (Meters) (Degrees) (Meters) Detector (Meters) (Meters	Frequency: cy Range: nsmitting/recei level Level (dBµV/m) 22.28 54 25.485 54 27.377 54 28.266 54	Fuller //cCollough ele Adepoju Page: 1 N/A N/A Above 1 ving Low Chann Level Margin (dB) .0 -31.7 .0 -28.5 .0 -26.6 .0 -25.7 .0 -24.9	Test Results Pass Pass Pass Pass Pass Pass Pass	
Test Technician Supervisor: Witness' Name Radiated Emissions Test Results Data Sheet	Frequency: cy Range: nsmitting/recei level lBµV/m) 22.28 54 25.485 54 27.377 54 28.266 54	N/A N/A Above 1	Test Results Pass Pass Pass Pass Pass Pass Pass	
Purchase Order #: Equip. Under Test: Single-Channel Wireless Remote Witness' Name	Rob Me: Bando Frequency: cy Range: nsmitting/recei level lBµV/m) 22.28 54 25.485 54 27.377 54 28.266 54	N/A N/A Above 1	Test Result Pass Pass Pass Pass Pass Pass Pass	
Radiated Emissions Test Results Data Sheet	Frequency: cy Range: nsmitting/recei level lBµV/m) 22.28 54 25.485 54 27.377 54 28.266 54	Page: 1 N/A N/A Above 1 Ving Low Chann Level Margin (dB) .0 -31.7 .0 -28.5 .0 -26.6 .0 -25.7 .0 -24.9	Test Result Pass Pass Pass Pass Pass Pass Pass	
Radiated Emissions Test Results Data Sheet	Frequency: cy Range: nsmitting/recei orrected Level BµV/m 22.28 54 25.485 54 27.377 54 28.266 54	Page: 1 N/A N/A Above 1 ving Low Channe Level (dB) Margin (dB) .0 -31.7 .0 -28.5 .0 -26.6 .0 -25.7 .0 -24.9	Test Result Pass Pass Pass Pass Pass Pass Pass	
Function Frequency Frequency Content Content Frequency Content Frequency Content Frequency Content Content Frequency Content Content Frequency Content Content Content Function Content Content Function Content Conten	cy Range: nsmitting/recei orrected Level (BµV/m) 22.28 54 25.485 54 27.377 54 28.266 54	N/A N/A Above 1 ving Low Chann Level Margin (dB) .0 -31.7 .0 -28.5 .0 -26.6 .0 -25.7 .0 -24.9	Test Result Pass Pass Pass Pass Pass Pass Pass	
Comparison	cy Range: nsmitting/recei orrected Level (BµV/m) 22.28 54 25.485 54 27.377 54 28.266 54	Above 1 ving Low Chanr Level Margin (dB) .0 -31.7 .0 -28.5 .0 -26.6 .0 -25.7 .0 -24.9	Test Results Pass Pass Pass Pass Pass Pass Pass	
EUT Mode of Operation: Tran Frequency Measured (MHz) Test Distance (Meters) EUT Direction (Meters) Antenna Height (Meters) Detector Function Recorded Amplitude (dBμV) Colspan="4">Amplitude (dBμV) Amplitude (dBμV) <t< td=""><td>nsmitting/recei orrected Level (dBµV/m) 22.28 54 25.485 54 27.377 54 28.266 54</td><td>ving Low Channel Level Margin (dB) .0 -31.7 .0 -28.5 .0 -26.6 .0 -25.7 .0 -24.9</td><td>Pass Pass Pass Pass Pass Pass Pass</td></t<>	nsmitting/recei orrected Level (dBµV/m) 22.28 54 25.485 54 27.377 54 28.266 54	ving Low Channel Level Margin (dB) .0 -31.7 .0 -28.5 .0 -26.6 .0 -25.7 .0 -24.9	Pass Pass Pass Pass Pass Pass Pass	
Frequency Measured (MHz) Test Distance (Meters) EUT Direction (Degrees) Antenna Height (Meters) Detector Function (dBμV) Recorded Amplitude (dBμV) Complete (dBμV) 1152.08 3 246 1 Average 35.1 24.5 2209.12 3 61 1 Average 34.5 24.5 3130.53 3 311 1 Average 34.9 24.9 4302.59 3 10 1 Average 33.5 24.9 5289.69 3 48 1 Average 32.5 24.9 5981.66 3 100 1 Average 31.3 34.9 7732.85 3 14 1 Average 27.6 34.9 8600.09 3 28 1 Average 27.5 34.9 1510.4 3 318 1 Average 27.5 34.9 12809.7 3 180 1 Average 27.6 44.9 <td colspan<="" td=""><td>orrected Level (dBμV/m) 22.28 54 25.485 54 27.377 54 28.266 54</td><td>Level (dB) .0 -31.7 .0 -28.5 .0 -26.6 .0 -25.7 .0 -24.9</td><td>Pass Pass Pass Pass Pass Pass Pass</td></td>	<td>orrected Level (dBμV/m) 22.28 54 25.485 54 27.377 54 28.266 54</td> <td>Level (dB) .0 -31.7 .0 -28.5 .0 -26.6 .0 -25.7 .0 -24.9</td> <td>Pass Pass Pass Pass Pass Pass Pass</td>	orrected Level (dBμV/m) 22.28 54 25.485 54 27.377 54 28.266 54	Level (dB) .0 -31.7 .0 -28.5 .0 -26.6 .0 -25.7 .0 -24.9	Pass Pass Pass Pass Pass Pass Pass
Measured (MHz) Distance (Meters) Direction (Degrees) Height (Meters) Detector Function Amplitude (dBμV) Identity 1152.08 3 246 1 Average 35.1 2 2209.12 3 61 1 Average 34.5 2 3130.53 3 311 1 Average 34.9 2 4302.59 3 10 1 Average 33.5 2 5289.69 3 48 1 Average 32.5 2 5981.66 3 100 1 Average 31.3 3 7732.85 3 14 1 Average 27.6 3 8600.09 3 28 1 Average 27.7 3 1510.4 3 318 1 Average 27.5 3 12809.7 3 180 1 Average 27.6 4 Professional Testing, EMI, Inc Radiated Emissions, 3m Distance 1-18GHz Hori	Level (dBµV) 22.28 54 25.485 54 27.377 54 28.266 54	//m) (dB) .0 -31.7 .0 -28.5 .0 -26.6 .0 -25.7 .0 -24.9	Pass Pass Pass Pass Pass Pass	
2209.12 3 61 1 Average 34.5 2 3130.53 3 311 1 Average 34.9 2 4302.59 3 10 1 Average 33.5 2 5289.69 3 48 1 Average 32.5 2 5981.66 3 100 1 Average 31.3 3 7732.85 3 14 1 Average 27.6 3 8600.09 3 28 1 Average 27.7 3 1510.4 3 318 1 Average 27.5 3 12809.7 3 180 1 Average 27.9 3 16626.2 3 189 1 Average 27.6 4 Professional Testing, EMI, Inc Radiated Emissions, 3m Distance 1-18GHz Horizontal Polarity Measured Emissions	25.485 54 27.377 54 28.266 54	.0 -28.5 .0 -26.6 .0 -25.7 .0 -24.9	Pass Pass Pass Pass	
3130.53 3 311 1 Average 34.9 2 4302.59 3 10 1 Average 33.5 2 5289.69 3 48 1 Average 32.5 2 5981.66 3 100 1 Average 31.3 3 7732.85 3 14 1 Average 27.6 3 8600.09 3 28 1 Average 27.7 3 11510.4 3 318 1 Average 27.5 3 12809.7 3 180 1 Average 27.9 3 16626.2 3 189 1 Average 27.6 4 Professional Testing, EMI, Inc Radiated Emissions, 3m Distance 1-18GHz Horizontal Polarity Measured Emissions	27.377 54 28.266 54	.0 -26.6 .0 -25.7 .0 -24.9	Pass Pass Pass	
4302.59 3 10 1 Average 33.5 2 5289.69 3 48 1 Average 32.5 2 5981.66 3 100 1 Average 31.3 3 7732.85 3 14 1 Average 27.6 3 8600.09 3 28 1 Average 27.7 3 11510.4 3 318 1 Average 27.5 3 12809.7 3 180 1 Average 27.9 3 16626.2 3 189 1 Average 27.6 4 Professional Testing, EMI, Inc Radiated Emissions, 3m Distance 1-18GHz Horizontal Polarity Measured Emissions	28.266 54	.0 -25.7 .0 -24.9	Pass Pass	
5289.69 3 48 1 Average 32.5 2 5981.66 3 100 1 Average 31.3 3 7732.85 3 14 1 Average 27.6 3 8600.09 3 28 1 Average 27.7 3 11510.4 3 318 1 Average 27.5 3 12809.7 3 180 1 Average 27.9 3 16626.2 3 189 1 Average 27.6 4 Professional Testing, EMI, Inc Radiated Emissions, 3m Distance 1-18GHz Horizontal Polarity Measured Emissions	/	.0 -24.9	Pass	
5981.66 3 100 1 Average 31.3 3 7732.85 3 14 1 Average 27.6 3 8600.09 3 28 1 Average 27.7 3 11510.4 3 318 1 Average 27.5 3 12809.7 3 180 1 Average 27.9 3 16626.2 3 189 1 Average 27.6 4 Professional Testing, EMI, Inc Radiated Emissions, 3m Distance 1-18GHz Horizontal Polarity Measured Emissions	29 098 54		_	
7732.85 3 14 1 Average 27.6 3 8600.09 3 28 1 Average 27.7 3 11510.4 3 318 1 Average 27.5 3 12809.7 3 180 1 Average 27.9 3 16626.2 3 189 1 Average 27.6 4 Professional Testing, EMI, Inc Radiated Emissions, 3m Distance 1-18GHz Horizontal Polarity Measured Emissions	_5.050 54		_	
8600.09 3 28 1 Average 27.7 3 11510.4 3 318 1 Average 27.5 3 12809.7 3 180 1 Average 27.9 3 16626.2 3 189 1 Average 27.6 4 Professional Testing, EMI, Inc Radiated Emissions, 3m Distance 1-18GHz Horizontal Polarity Measured Emissions	30.947 54	.0 -23.0	Pass	
11510.4 3 318 1 Average 27.5 3 12809.7 3 180 1 Average 27.9 3 16626.2 3 189 1 Average 27.6 4 Professional Testing, EMI, Inc Radiated Emissions, 3m Distance 1-18GHz Horizontal Polarity Measured Emissions	34.117 54	.0 -19.8	Pass	
12809.7 3 180 1 Average 27.9 3 16626.2 3 189 1 Average 27.6 4 Professional Testing, EMI, Inc Radiated Emissions, 3m Distance 1-18GHz Horizontal Polarity Measured Emissions	35.884 54		Pass	
16626.2 3 189 1 Average 27.6 4 Professional Testing, EMI, Inc Radiated Emissions, 3m Distance 1-18GHz Horizontal Polarity Measured Emissions	38.754 54		Pass	
Professional Testing, EMI, Inc Radiated Emissions, 3m Distance 1-18GHz Horizontal Polarity Measured Emissions	39.017 54	.0 -14.9	Pass	
Radiated Emissions, 3m Distance 1-18GHz Horizontal Polarity Measured Emissions	43.489 54	.0 -10.5	Pass	
88 70 18 19 40 30 70 Operator: Larry Fuller Frequency 2013 Rad Emissions ClassB 020414 Run02 Low Rerun EUC.NIode: Transmitting/receiving hoping	Peak Limit I Corrected Po		18G ote Unit (WRU) Mo	

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Test Metho	od:	ANSI C63.4-2		sional Te	sung, Er	VII. IIIC			
	od:					···, ·····			
n accorda	Electronic Equipment in the Range of 9 kHz to 40 GHz" (incorporated by reference, see §15.38). FCC Part 15.209 - Code of Federal Regulations Part 47, Subpart C - Intentional Radiators, Radiated Emissions								
In accordance with: Limits								ators, Radiate	ed Emissio
Section:		15.209							
Test Date(s):	5/13/2014			EUT Serial	#:	120800000	150	
Customer:		Wireless Se	ismic		EUT Part #:		N/A		
Project Number: 15298-15 Test Technician: Larry Fuller									
Purchase Order #: Supervisor: Rob McCollough									
Equip. Under Test: Single-Channel Wireless Remote Witness' Name: Bandele Adepoju									
Radiated Emissions Test Results Data Sheet Page: 1 of 1									
	ine Voltage:		7 VDC			ver Frequen		/A N/A	
Antenn	a Orientatio	n:	Vertic	al	Frequ	ency Range		Above 1	GHz
EUT Mode of Operation: Transmitting/receiving Mid Channel									
Frequency Measured (MHz)	Test Distance (Meters)	EUT Direction (Degrees)	Antenna Height (Meters)	Detector Function	Recorded Amplitude (dBµV)	Corrected Level (dBµV/m)	Limit Level (dBµV/m)	Margin (dB)	Test Res
1153.26	3	212	1	Average	35.2	22.387	54.0	-31.6	Pass
2222.66	3	228	1	Average	34.6	25.579	54.0	-28.4	Pass
3118.62	3	143	1	Average	34.9	27.405	54.0	-26.6	Pass
4294.86	3	64	1	Average	33.7	28.451	54.0	-25.5	Pass
5301.42	3	291	1	Average	32.5	29.112	54.0	-24.8	Pass
5996.72	3	33	1	Average	31.3	31.028	54.0	-22.9	Pass
7731.57	3	150	1	Average	27.8	34.271	54.0	-19.7	Pass
8581.85	3	40	1	Average	27.8	35.896	54.0	-18.1	Pass
11497.6	3	196	1	Average	27.4	38.694	54.0	-15.3	Pass
12815.6	3	198	1	Average	27.9	39.003	54.0	-15.0	Pass
16630.3	3	259	1	Average	27.6	43.462	54.0	-10.5	Pass
Radiated 1-18GHz 90 F 80 Radiated 1-18GHz 90 Radiated 1-	∨ :: Larry Fuller	Measured Emission	7	Freque: Transmitting/rec		Cor Pes — Cor	rage Limit Level rected Average R k Limit Level rected Peak Readi	PROFESS Wireless Remote	18G
02:59:04	PM, Tuesday, May		Middle c	er: 3.7 VDc hannel I Antenna Po	1 11		ient: Wireless Seis	mic	

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			Profess	sional Te	sting, EN	VII, Inc.				
Test Metho	d:			ds of Measurer e Range of 9 kH				_		
In accordar	ice with:	FCC Part 15.2 Limits	09 - Code of I	ederal Regulat	tions Part 47, S	Subpart C - Int	entional Radi	ators, Radiat	ed Emissi	ons
Section:		15.209								
Test Date(s):	5/13/2014			EUT Serial	# :	120800000	150		
Customer:		Wireless Se	eless Seismic EUT Part #: N/A							
	t Number: 15298-15 Test Technician: Larry Fuller									
Purchase O	rder #:				Supervisor:		Rob McCol	lough		
Equip. Und	er Test:	Single-Char	nel Wireles	s Remote	Witness' N	ame:	Bandele A	depoju		
	F	Radiated Em	issions Test	Results Data	a Sheet		Pa	ge: 1	of	1
EUT Li	ne Voltage	: 3	7 VDC		EUT Pow	er Frequen	cy: N	/A N/A		
Antenna	Orientation	n:	Horizor	ital	Frequ	ency Range		Above 1	GHz	
	EUT N	/lode of Ope	ration:		1	Transmitting	g/receiving	Mid Chann	el	
Frequency Measured (MHz)	Test Distance (Meters)	EUT Direction (Degrees)	Antenna Height (Meters)	Detector Function	Recorded Amplitude (dBµV)	Corrected Level (dBμV/m)	Limit Level (dBµV/m)	Margin (dB)	Test Re	sult
1152.3	3	135	1	Average	35.2	22.365	54.0	-31.6	Pas	S
2219.96	3	242	1	Average	34.5	25.472	54.0	-28.5	Pas	S
3129.98	3	128	1	Average	34.9	27.45	54.0	-26.5	Pas	S
4305.74	3	120	1	Average	33.7	28.455	54.0	-25.5	Pas	S
5296.37	3	260	1	Average	32.5	29.132	54.0	-24.8	Pas	S
5997.73	3	181	1	Average	31.4	31.075	54.0	-22.9	Pas	s
7734.7	3	111	1	Average	27.7	34.216	54.0	-19.7	Pas	s
8590.29	3	192	1	Average	27.7	35.851	54.0	-18.1	Pas	S
12799.5	3	21	1	Average	27.9	39.004	54.0	-15.0	Pas	S
16617.2	3	237	1	Average	27.5	43.434	54.0	-10.5	Pas	S
Radiated 1-18GHz 90 (m) And 10 (m) 70	Emissions, 3m Dis Horizontal Polar		sions	Freq	y y uency	∨ Con — Per — Con	rrage Limit Level rrected Average R lsk Limit Level rrected Peak Read	PROFESS	18G	J) Mo
	Emissions_ClassB_ PM, Tuesday, Ma			le: Transmitting/rec er: 3.7 VDc hannel	eiving hoping		roject Number: 15 lient: Wireless Sei			

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			Profess	sional Te	sting, El	MI, Inc.			
Test Metho	d:			ds of Measurer e Range of 9 kH					
In accordar	ice with:	FCC Part 15.2 Limits	209 - Code of I	ederal Regulat	tions Part 47, S	Subpart C - Int	entional Rad	iators, Radiat	ed Emissions
Section:		15.209							
Test Date(s):	5/13/2014			EUT Serial	#:	120800000	150	
Customer:		Wireless Se	eismic		EUT Part #:		N/A		
Project Nur									
Purchase O	rder #:				Supervisor		Rob McCol	llough	
Equip. Under Test: Single-Channel Wireless Remote Witness' Name: Bandele Adepoju									
	F	Radiated Em	issions Test	Results Data	a Sheet		Pa	ge: 1	of 1
EUT Li	ne Voltage	: 3	.7 VDC		EUT Pow	ver Frequen	cy: N	/A N/A	
Antenna	Orientatio	n:	Vertic	al	Frequ	ency Range:		Above 1	GHz
	EUT N	/lode of Ope	eration:		Т	ransmitting	receiving	High Chann	el
Frequency Measured (MHz)	Test Distance (Meters)	EUT Direction (Degrees)	Antenna Height (Meters)	Detector Function	Recorded Amplitude (dBµV)	Corrected Level (dBµV/m)	Limit Level (dBµV/m)	Margin (dB)	Test Results
1149.54	3	324	1	Average	35.2	22.328	54.0	-31.6	Pass
2216.88	3	248	1	Average	34.6	25.535	54.0	-28.4	Pass
3120.92	3	41	1	Average	34.9	27.433	54.0	-26.5	Pass
4312.59	3	308	1	Average	33.6	28.385	54.0	-25.6	Pass
5305.57	3	123	1	Average	32.5	29.11	54.0	-24.8	Pass
5973.84	3	240	1	Average	31.3	30.825	54.0	-23.1	Pass
7732.49	3	208	1	Average	27.7	34.238	54.0	-19.7	Pass
8594.84	3	22	1	Average	27.8	35.957	54.0	-18.0	Pass
11502.9	3	254	1	Average	27.5	38.759	54.0	-15.2	Pass
12814.2	3	286	1	Average	28	39.038	54.0	-14.9	Pass
16640.2	3	72	1	Average	27.6	43.506	54.0	-10.5	Pass
Radiated 1-18GHz 90	ional Testing, Emissions, 3m Dis Vertical Polarity		ns			▽ Cor — Pea	erage Limit Level rected Average F ak Limit Level rected Peak Read	Reading	SIONAL
Field Strength (dBµV/m) 00 00 00 00	and the state of t			Million de la companya de la company			And Market		
	_		7	Y	Ĭ Ĭ				

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> 1GHz Vertical Antenna Polarity Measured Emissions

1 4.5.	10. 110112	.ontai, spi		diated Emi sional Te			e i dnz, i	ngn Chai	11161
Test Metho	d:		2003: "Metho	ds of Measurer e Range of 9 kF	ment of Radio	-Noise Emissio		_	
In accordan	ice with:	FCC Part 15.2 Limits	209 - Code of I	ederal Regulat	tions Part 47, S	Subpart C - Int	entional Radi	ators, Radiat	ed Emissions
Section:		15.209					_		
Test Date(s):	5/13/2014			EUT Serial	#:	120800000	150	
Customer:		Wireless Se	eismic		EUT Part #:		N/A		
Project Nur	nber:	15298-15			Test Techn	ician:	Larry Fulle		
Purchase O	rder #:				Supervisor		Rob McCol		
Equip. Und	er Test:	Single-Char	nnel Wireles	s Remote	Witness' N	ame:	Bandele A	depoju	
Radiated Emissions Test Results Data Sheet Page: 1 of 1									
EUT Li	ne Voltage	: 3	.7 VDC		EUT Pow	ver Frequen	cy: N	/A N/A	
Antenna	Orientatio	n:	Horizor	ıtal	Frequ	ency Range:		Above 1	GHz
EUT Mode of Operation: Transmitting/receiving High Channel									
Frequency Measured (MHz)	Test Distance (Meters)	EUT Direction (Degrees)	Antenna Height (Meters)	Detector Function	Recorded Amplitude (dBµV)	Corrected Level (dBµV/m)	Limit Level (dBµV/m)	Margin (dB)	Test Results
1158.79	3	32	1	Average	35.1	22.319	54.0	-31.6	Pass
2220.06	3	204	1	Average	34.5	25.459	54.0	-28.5	Pass
3124.11	3	8	1	Average	34.8	27.373	54.0	-26.6	Pass
4303.8	3	90	1	Average	33.6	28.424	54.0	-25.5	Pass
5295.92	3	117	1	Average	32.5	29.087	54.0	-24.9	Pass
5995.12	3	333	1	Average	31.4	31.035	54.0	-22.9	Pass
7738.6	3	147	1	Average	27.7	34.251	54.0	-19.7	Pass
8597.93	3	225	1	Average	27.6	35.759	54.0	-18.2	Pass
11514.3	3	126	1	Average	27.4	38.682	54.0	-15.3	Pass
12817.4	3	333	1	Average	28	39.091	54.0	-14.9	Pass
16638.1	3	45	1	Average	27.6	43.507	54.0	-10.5	Pass
Radiated 1-18GHz	ional Testing, Emissions, 3m Dis Horizontal Polar		sions			 ∇ Coi Per 	erage Limit Level rrected Average R ak Limit Level rrected Peak Read	Reading	SIONAL
Field Strength (dBµV/m) Strength (dBµV/m) Field Strength (dBµV/m) Strength (dBµV/m)	▽ : Larry Fuller			Free	y y	Y E	10G UT: Single-Channe	el Wireless Remot	18G e Unit (WRU) Mo
	Emissions_ClassB_PM, Tuesday, Ma	'	gh_FCC.t E UT Mo EUT Pow High cha	de: Transmitting/rec er: 3.7 VDc			roject Number: 15 lient: Wireless Sei		

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> 1GHz Horizontal Antenna Polarity Measured Emissions

Table 4.3.11: Vertical, Spurious Radiated Emissions - T/R, 18-25 GHz, Low Channel

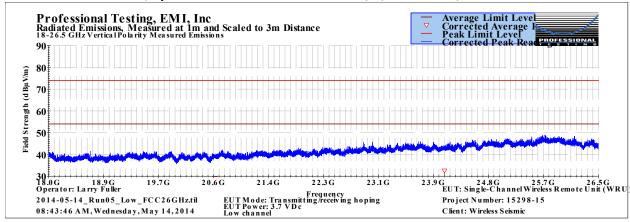
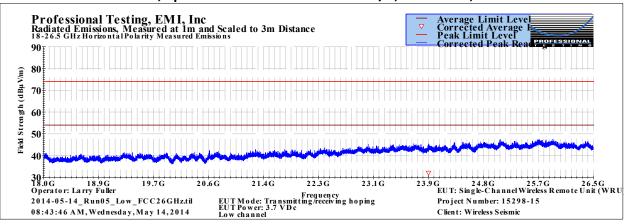


Table 4.3.12: Horizontal, Spurious Radiated Emissions – T/R, 18-25 GHz, Low Channel



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Table 4.3.13: Vertical, Spurious Radiated Emissions – T/R, 18-25 GHz, Mid Channel

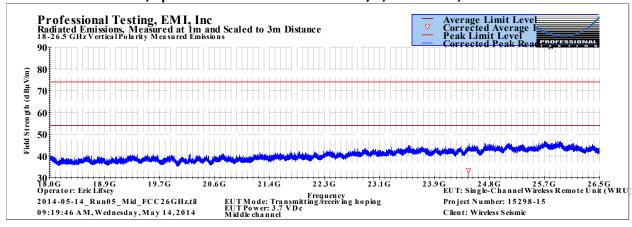
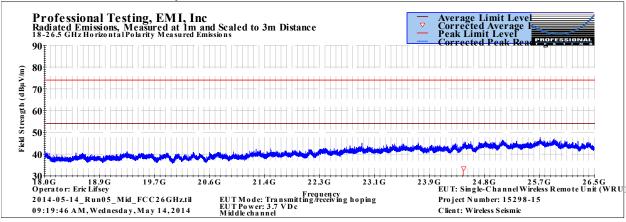


Table 4.3.14: Horizontal, Spurious Radiated Emissions - T/R, 18-25 GHz, Mid Channel



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Table 4.3.15: Vertical, Spurious Radiated Emissions – T/R, 18-25 GHz, High Channel

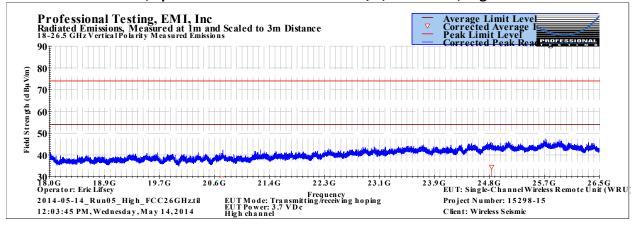
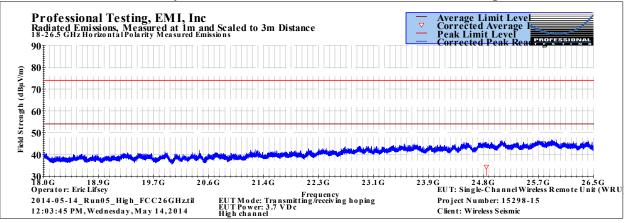


Table 4.3.16: Horizontal, Spurious Radiated Emissions – T/R, 18-25 GHz, High Channel



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Table 4.3.17: Spurious Radiated Emissions – Instrument Bandwidth and Measurement Time

Radiat	ed Emissions Spectrum A	nalyzer Bandwidth and	Measurement Time - Pe	ak Scan
Frequency Band Start (MHz)	Frequency Band Stop (MHz)	6 dB Bandwidth (kHz)	Number of Ranges Used	Measurement Time per Range
0.009	0.15	0.3	2	Multiple Sweeps
0.15	30	9	6	Multiple Sweeps
30	1000	120	2	Multiple 800 mS Sweeps
1000	6000	1000	2	Multiple Sweeps
6000	18000	300	2	Multiple Sweeps

*Notes:

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^{1.} The settings above are specifically calculated for the E4440A series of spectrum analyzers, which have 8,000 data points per range.

^{2.} The measurement receiver resolution bandwidth setting was 300 Hz for quasi-peak measurements from 9-150 kHz.

^{3.} The measurement receiver resolution bandwidth setting was 9 kHz for quasi-peak measurements from 0.15-30 MHz.

^{4.} The measurement receiver resolution bandwidth setting was 120 kHz for quasi-peak measurements from 30-1000 MHz.

^{5.} The measurement receiver resolution bandwidth setting was 1 MHz for average measurements from 1-18 GHz.

4.4 Test Equipment

4.4 1 es	L Equipment			· · · · · · · · · · · · · · · · · · ·		
		Profes	sional Te	esting, EMI, Inc.		
Test Method	1:			surement of Radio-Noise in the Range of 9 kHz to		
				egulations Part 47, Subpa		
In accordan		ited Emissions Limi		- Sanata		,
Section:	15.20	9				
Test Date(s)	: 5/13/	/2014		EUT Serial #:	120800000150	
Customer:		ess Seismic		EUT Part #:	N/A	
Project Num		3-15		Test Technician:	Larry Fuller	
<u>Purchase Or</u> Equip. Unde		e-Channel Wireless	Pomoto	Supervisor: Witness' Name:	Rob McCollough Bandele Adepoju	
Equip. Onue	i rest. Siligit				bandele Adepoju	
		Radiate	d Emissions	Test Equipment List		
Til	e! Software Version	on: 4.2.A,	May 23, 20	10, 08:38:52 AM		
	Test Profile:	Radia	ted Emissio	ns_Profile Version Octob	er 12, 2011	
Asset #	Manufacturer	Model	Equipr	ment Nomenclature	Serial Number	Calibration Due Date
1509A	Braden	N/A	TDK 10M	Chamber, NSA < 1 GHz	DAC-012915-005	7/29/2014
1890	НР	8447F	Preamp/	Amp, 9kHz-1300MHz, 28/25dB	3313A05298	1/22/2015
1937	Agilent	E4440A	Spectrum Analyzer, 3 Hz - 26.5 GHz		MY44303298	12/2/2015
1926	ETS-Lindgren	3142D	Antenna, Biconilog, 26 MHz - 6 GHz		00135454	7/29/2014
C027	N/A	RG214	Cable Coax, N-N, 25m		none	9/26/2014
1327	EMCO	1050	Contro	oller, Antenna Mast	none	N/A
0942	EMCO	11968D	7	urntable, 4ft.	9510-1835	N/A
1969	HP	11713A	Attenu	uator/Switch Driver	3748A04113	N/A
1542	A.H. Systems	SAS-572	Antenna,	Horn 18-26.5GHz, 20dB gain	225	N/A
1509B	Braden	N/A	TDK 10M C	Chamber, VSWR > 1 GHz	DAC-012915-005	7/16/2014
2004	Miteq	AFS44-00101800- 2S-10P-44	Amplit	fier, 40dB, .1-18GHz	0	11/19/2014
C030	N/A	0		e Coax, N-N, 30m	none	9/26/2014
Loaner-ETS	ETS-Lindgren	3117		Double Ridged Guide orn, 1 - 18 GHz	135203	1/14/2015
1325	EMCO	1050	Contro	oller, Antenna Mast	9003-1461	N/A
1973	Agilent	83017A	Amplifier,	Microwave 0.5-26.5 GHz	MY39500497	1/16/2015

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5 Spurious Emissions, Receiver, Radiated

The EUT alternately transmits and receives. The measurements in the previous section for transmit mode will apply.

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6 Transmitter Unwanted Emissions, Band Edge, Conducted

6.1 Test Procedure

EUT is placed into normal transmit operation on the nearest band edge channel. The spectrum analyzer is centered on the band edge frequency with span sufficient to include the peak of the adjacent fundamental signal. Using peak detection, the analyzer measures emissions in maxhold mode. The measurement range includes two standard bandwidths from the respective band edge and some beyond to see the emission profile clearly. If required, the band-edge marker-delta method of C63.4 is utilized.

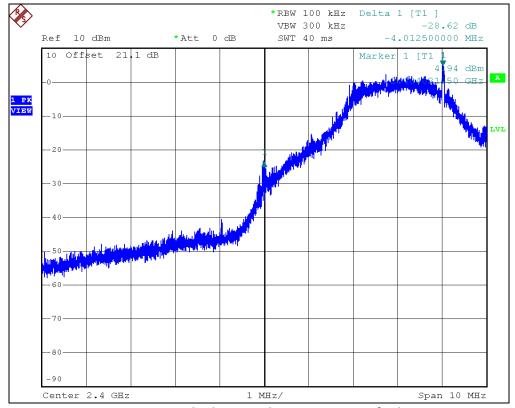
6.2 Test Criteria

47 CFR (USA) // IC (Canada)	47 CFR (USA) // IC (Canada)							
Section Reference	Parameter	Date(s)						
15.247, 15.205, 15.209 //	Unwanted Emissions Adjacent to Authorized	2014-05-15						
RSS-Gen Issue 3, 4.9	Band, Conducted	2014-05-15						

The limit applied is according to whether or not a restricted band applies.

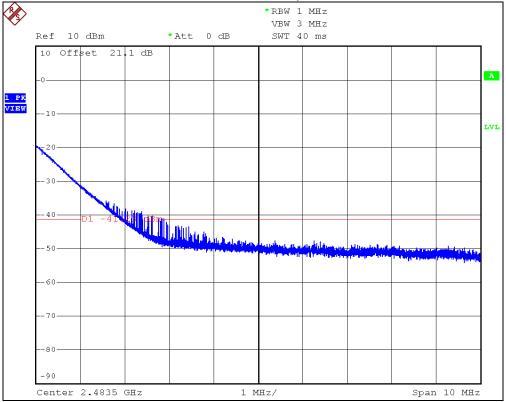
6.3 Test Results

The EUT satisfied the criteria. Measured results appear below.



Lower Band Edge, -20 dBc Criteria Satisfied

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Upper Band Edge, 15.209 Criteria Satisfied

6.4 Test Equipment

Asset #	Manufacturer	Model #	Description	Calibration Due
ALN-077	Rohde & Schwarz	FSP-30	Spectrum Analyzer	2015-01-29
C248	Pasternack	N/A	Cable	2015-05-14
A105	Narda	768A-20	RF Attenuator, 20 W, 20 dB	2015-05-16
0881	Thermotron	S-1.2C	Environmental Chamber S/N 27131	2014-09-13
None	None BK Precision		Bench Power Supply S/N 261 0200 0081	Cal In Use
2087	Fluke	189	DMM, True RMS	2015-03-06

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7 Transmitter/Receiver, Unwanted Emissions, Conducted

Conducted spurious measurements were made on the receiver at the Professional Testing Site 45, located in Austin, Texas, determine the radio frequency noise conducted from the EUT on the antenna port.

7.1 Test Procedure

The transmitter was operated with modulation and in frequency hopping mode for measurements below the operating band. Measurements above 3 GHz were in unmodulated mode on fixed non-hopping channels.

7.2 Test Criteria

47 CFR (USA) // IC (Canada)							
Section Reference	Parameter	Date(s)					
15.247, 15.209 //	Conducted Spurious/Harmonic	2014-05-15					
RSS-Gen Issue 3, 4.9, 4.10	Emissions	2014-05-15					

7.3 Test Results

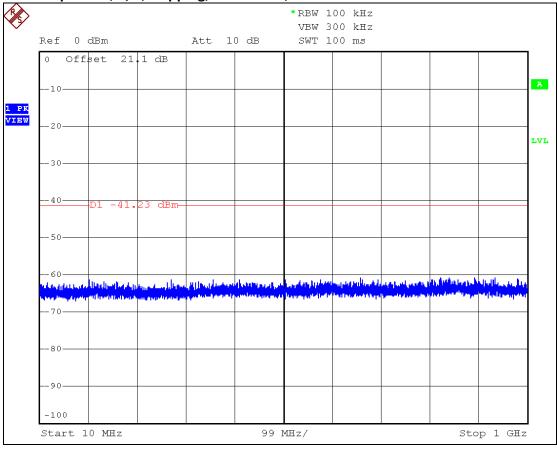
Emissions were measured with a spectrum analyzer. The EUT was transmitting into a resistive RF power attenuator rated 20 Watts 20 dB. Factors for losses and attenuator were directly input into the spectrum analyzer as a reference level offset.

The EUT was operated in hopping mode for measurements up to an including the operating band, such that it could be seen that the transmitter was operating and in hopping mode. Above the operating band, the measurement began at just below the operating band so the non-hopping transmit signal could be confirmed. Measurements were taken up to 25 GHz. Visual inspection of the plots confirms no measureable emissions in the required spectrum.

The conducted emissions generated by the EUT were below the applicable limits.

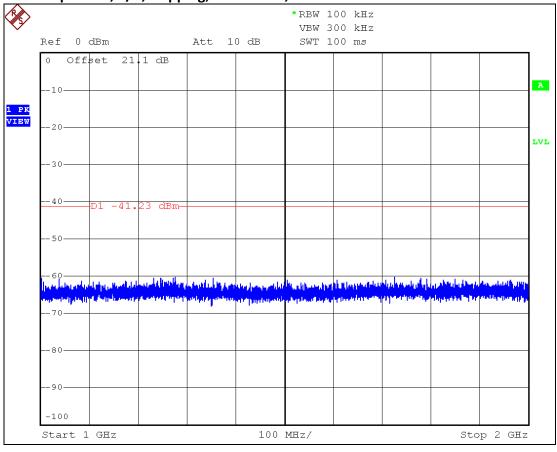
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Table 7.3.1: Spurious, T/R, Hopping, Conducted, 10 MHz to 1000 MHz



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Table 7.3.2: Spurious, T/R, Hopping, Conducted, 1000 MHz to 2000 MHz



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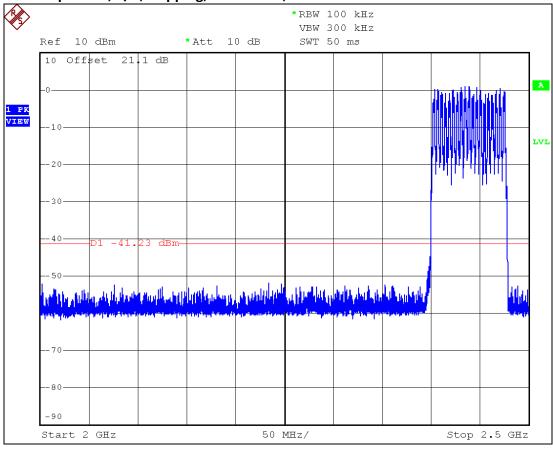
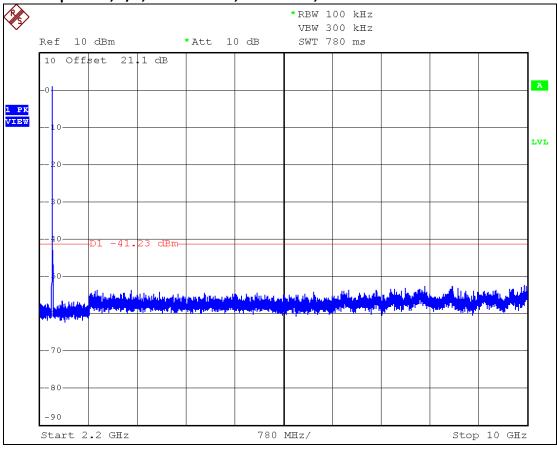


Table 7.3.2: Spurious, T/R, Hopping, Conducted, 2000 MHz to 2500 MHz

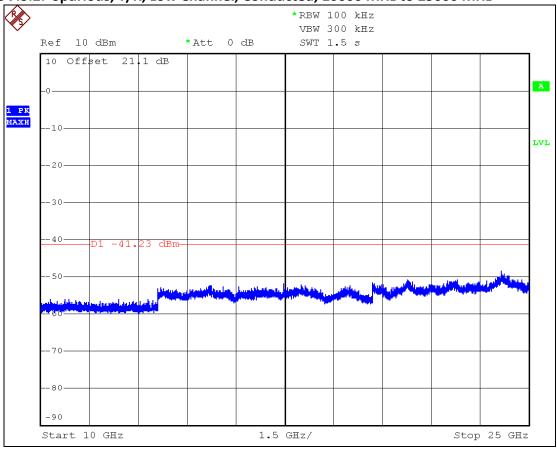
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Table 7.3.2: Spurious, T/R, Low Channel, Conducted, 2200 MHz to 10000 MHz



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Table 7.3.2: Spurious, T/R, Low Channel, Conducted, 10000 MHz to 25000 MHz



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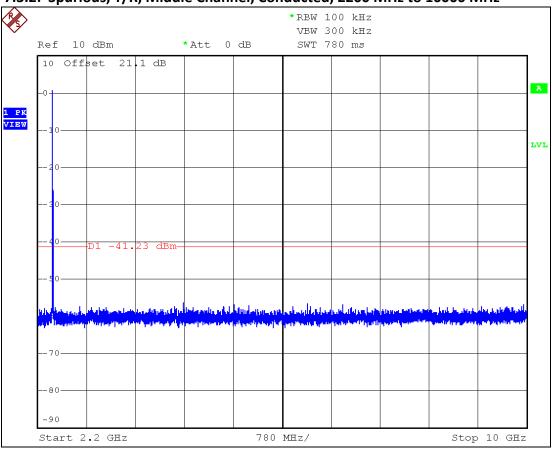


Table 7.3.2: Spurious, T/R, Middle Channel, Conducted, 2200 MHz to 10000 MHz

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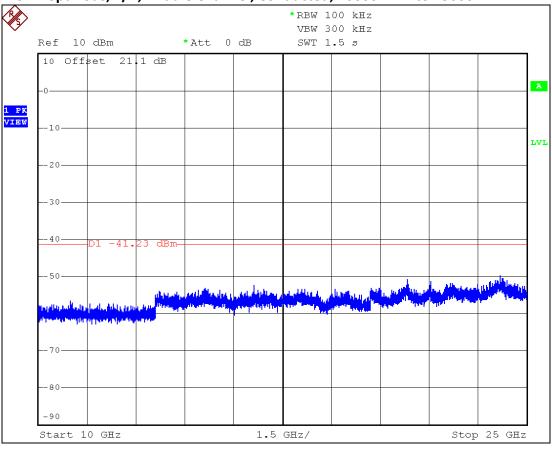


Table 7.3.2: Spurious, T/R, Middle Channel, Conducted, 10000 MHz to 25000 MHz

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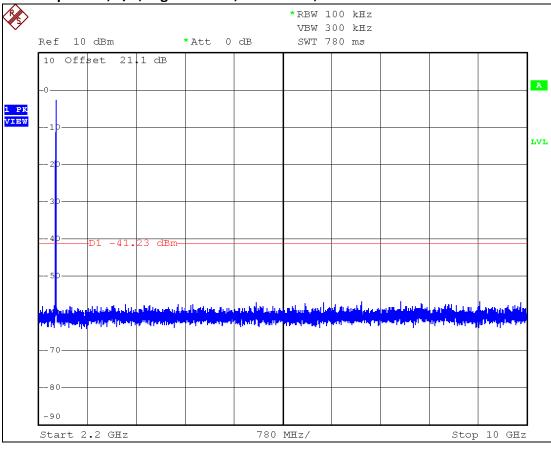


Table 7.3.2: Spurious, T/R, High Channel, Conducted, 2200 MHz to 10000 MHz

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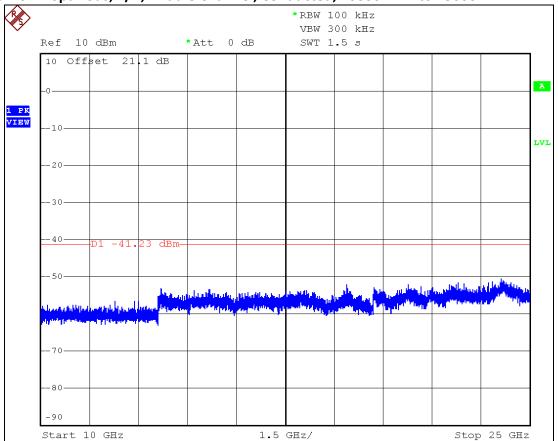


Table 7.3.2: Spurious, T/R, Middle Channel, Conducted, 10000 MHz to 25000 MHz

7.4 Test Equipment

Asset #	Manufacturer	Model #	Description	Calibration Due
ALN-077	Rohde & Schwarz	FSP-30	Spectrum Analyzer	2015-01-29
C248	Pasternack	N/A	Cable	2015-05-14
A105	Narda	768A-20	RF Attenuator, 20 W, 20 dB	2015-05-16

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8 Occupied Bandwidth

8.1 Test Procedure

The measurement was performed using conducted coupling via power attenuator. Hopping is disabled for this test.

8.2 Test Criteria

This measurement is performed for verifying minimum bandwidth, for other reporting purposes, and to determine bandwidth required for entire bandwidth power measurement.

8.3 Test Results

Bandwidth 6 dB	
Minimum 500 kHz	

Low Channel Measured BW (kHz)	Measured BW Measured BW		Minimum BW (kHz)
2000.0	2004.5	2009.0	2000.0

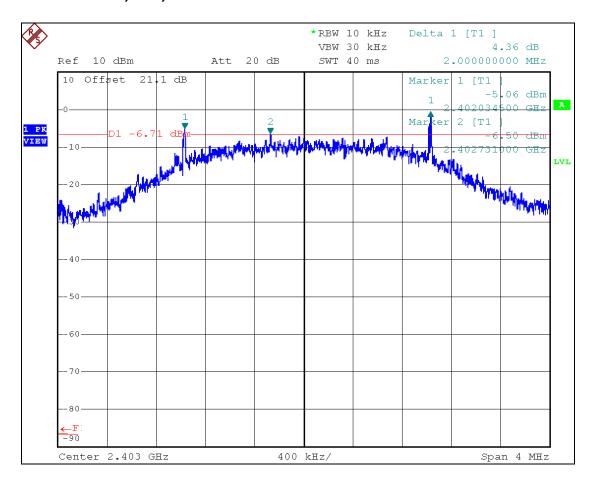
Bandwidth 20 dB	
Measure and Report	

Low Channel	Mid Channel	High Channel	Reported
Measured BW	Measured BW Measured BW		Maximum BW
(kHz)	(kHz)	(kHz)	(kHz)
3093.5	2776.0	2888.0	3093.5

Plotted measurements appear on the following pages.

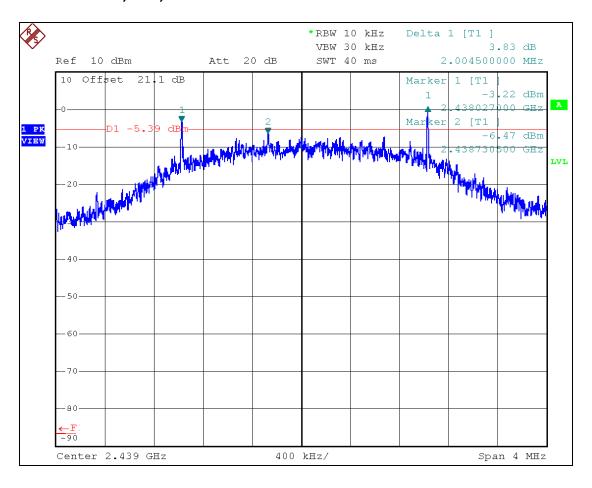
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Plot 8.3.1 Bandwidth, 6 dB, Low Channel



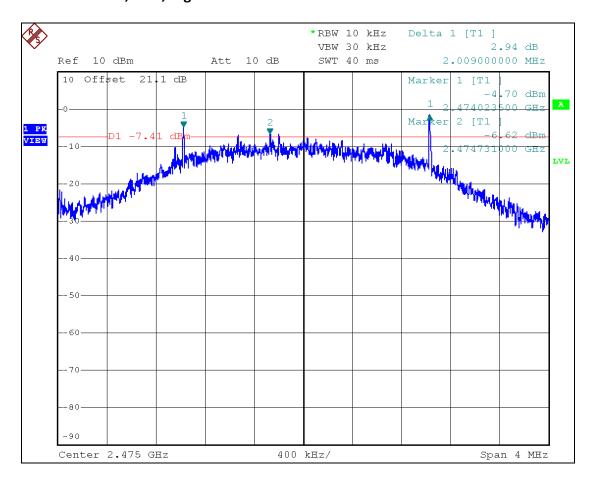
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Plot 8.3.2 Bandwidth, 6 dB, Middle Channel



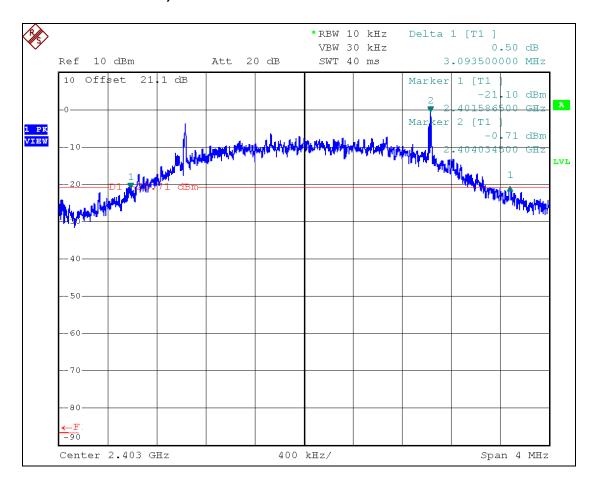
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Plot 8.3.3 Bandwidth, 6 dB, High Channel



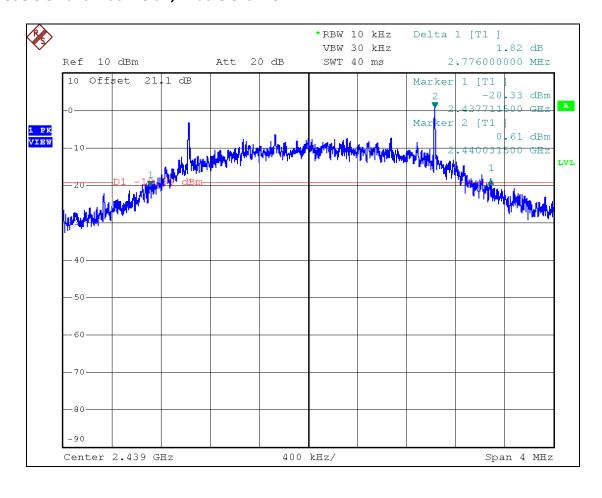
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Plot 8.3.4 Bandwidth 20 dB, Low Channel



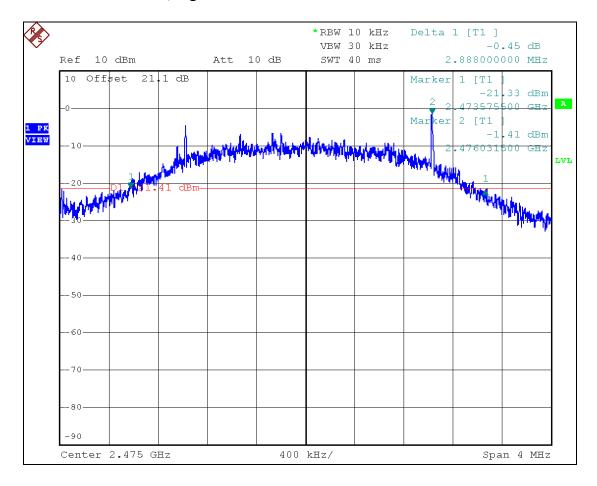
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Plot 8.3.5 Bandwidth 20 dB, Middle Channel



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Plot 8.3.6 Bandwidth 20 dB, High Channel



8.4 Test Equipment

Asset #	Manufacturer	Model #	Description	Calibration Due
ALN-077	Rohde & Schwarz	FSP-30	Spectrum Analyzer	2015-01-29
C248	Pasternack	N/A	Cable	2015-05-14
A105	Narda	768A-20	RF Attenuator, 20 W, 20 dB	2015-05-16

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9 Frequency Hopping Characteristics

This is a frequency hopping device. Number of hopping channels, channel occupancy time and channel spacing were evaluated. Data reported is for the observed worst-case operating mode of the EUT. Occupied bandwidth was used as the limit for channel spacing and is reported in the appropriate section of this report.

9.1 Test Procedure

A conducted setup was used for this evaluation. 'Zero span' mode was used on the spectrum analyzer to measure time.

9.2 Test Criteria

Hopping Criteria				
Parameter	Limit			
Number of Hopping Channels	15, or 15 / BW			
Hopping Channel Separation, Minimum	OBW or 100 kHz			
Maximum Accumulated Dwell Time	400 ms			

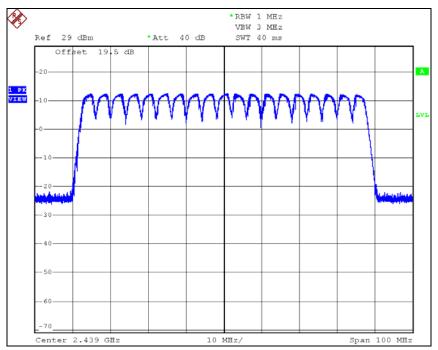
9.3 Test Results

Hopping Time Measurements					
Parameter	Measurement	Units			
Number of Hopping Channels (minimum 15)	19	channels			
Hopping Channel Separation	3.998	MHz			
Channel Dwell Time	6.1	ms			
Return to Channel Time	304	ms			

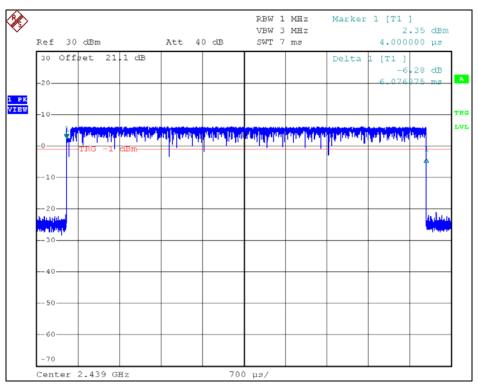
Occupancy Calculations				
Parameter	Calculation	Result		
Time to Assess Occupancy Time (Period)	400 ms * 19 channels	7.6 s		
Number of Channel Events over Period	7.6 s / 304 ms	25 events		
Accumulated Dwell Time (limit 400 ms)	25 * 6.1 ms	152.5 ms		

The EUT satisfies the criteria. Plotted measurements appear on the following pages.

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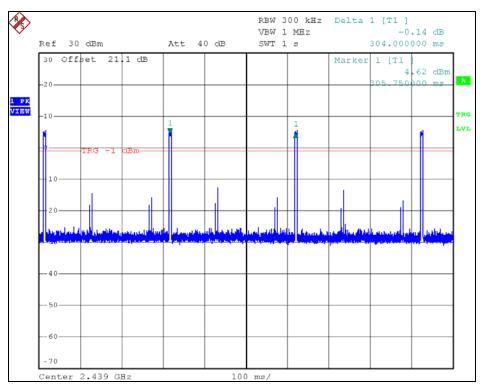


Number of Hopping Channels

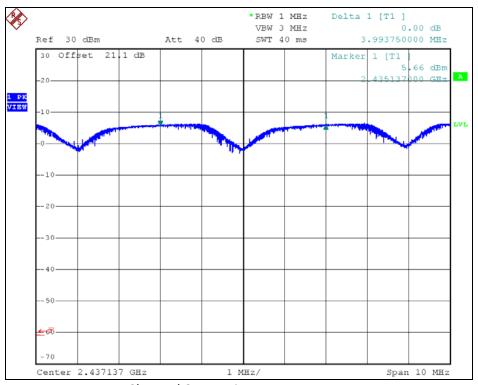


Channel Dwell Time (Worst-Case)

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Return to Channel Measurement



Channel Separation Measurement

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9.4 Test Equipment

Asset #	Manufacturer	Model #	Description	Calibration Due
ALN-077	Rohde & Schwarz	FSP-30	Spectrum Analyzer	2015-01-29
C248	Pasternack	N/A	Cable	2015-05-14
A105	Narda	768A-20	RF Attenuator, 20 W, 20 dB	2015-05-16

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9.5 Hopping Protocol Details

The following pseudo-random hopping table illustrates the logical and physical channels on which the transceiver hops. The starting point is chosen pseudo-randomly. Each sequential hop uses the next row in the table and then repeats from the last row back to the first.

Table of Hopping Channels and Frequencies

			eis and riequence	
Channel Index	Hop magnitude from last (+ direction)	Hop magnitude from last (- direction)	Frequency (MHZ)	Frequency change (MHZ)
4	5	-14	2415	-56
12	8	-11	2447	32
17	5	-14	2467	20
8	10	-9	2431	-36
1	12	-7	2403	-28
5	4	-15	2419	16
11	6	-13	2443	24
19	8	-11	2475	32
2	2	-17	2407	-68
7	5	-14	2427	20
16	9	-10	2463	36
10	13	-6	2439	-24
3	12	-7	2411	-28
14	11	-8	2455	44
6	11	-8	2423	-32
15	9	-10	2459	36
9	13	-6	2435	-24
13	4	-15	2451	16
18	5	-14	2471	20

There are two modes of operation for the LIU and WRU devices: 1) discovery and 2) cycle (or hopping). Each process will be described separately below.

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Discovery

During discovery, two units interact such that one is the master and the other is the slave. This mode uses a table of 19 channels. These are the same 19 channels used during cycle mode. The master begins the interaction by transmitting a beacon request on the frequency that would be used in cycle mode if the unit was currently connecting in cycle mode. The master will continue to beacon on each cycle until the slave responds. This assures that all 19 channels will be used so that the beacon at some point will align with the channel the slave is listening on. The transmitter begins at the index that the normal hopping sequence would have used at the cycle. The beacon message contains information on the node it expects to respond to the beacon and a table index which is the channel that the Beacon is transmitted on. Upon completion of the transmission, the master listens. This process repeats every 16 ms until the master establishes communications with 1 and only 1 other device. The Master after receiving the slave's response will send a ACK acknowledging to the Slave that he heard his response. This message exchange is similar to what happens in cycle mode.

The timing for the functional beacon cycle is:

□ Beacon Request (Tx from LIU)= 206.3 μsec

□ Beacon Response (Tx from WRU)=150.3 μsec

□ Response ACK (Tx from LIU) =147.1 μsec

□ Total = 503.7 μsec

The maximum time of occupancy of any channel for a device in discovery-master mode over the specified period in section (iii) above is 239.25 ms (see below). The discovery-mode uses one channel per cycle.

P=0.4~s*19=7.6~seconds where P is the period within which average channel occupancy < 400 ms C=7.6~s/16ms=475 where C is the number of beacon cycles within P O=(206.3us+150.3+147.1)*475=239.~25~ms $O_s=206.3us*475=97.9ms$ where O is the average channel occupancy within P

Where O_s is the channel occupancy of the single longest transmission from a device.

The scenario above is worst case description. The full 503.7 us transmission set would never occur more than once. The typical cycle would be the 206.3 us Beacon request without a response. Once the response occurs (a single 503.7 us transmission set) the LIU and WRU move to cycle mode and no longer use beacon mode. The real time of occupancy is closer to 97.9 ms.

The worst case single device transmission time will be 206.3 us. The worst case exchange on one frequency before hopping will be 503.7 us.

The slave device periodically turns on its receiver to listen for the Beacon messages. The period is randomly selected between 1 and 1.5 sec. This

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random process is designed to reduce the likelihood that several slave devices in the vicinity will hear and respond to the master's messages. The receiver channel is pseudo-randomly chosen from the same 19 channel table as the master. If within 304 ms, the slave does not hear a Beacon message, the receiver is shut off and the process begins again. If the slave does hear the Beacon message, it will set its receiver to the channel specified by the index contained within the message and respond. Upon reception of the Beacon message the slave will respond by transmitting a Beacon response message containing pertinent information to the slave device. Clearly the slave does not violate the average channel occupancy limit described above.

Cycle

Before describing the channel hopping process it is necessary to describe the transition from discovery mode to cycle mode.

The transition, which Wireless Seismic, Inc. refers to as "formation," is very similar to the discovery process. The process begins with the LIU being provided with the linear order of the WRU devices in its control (seismic instruments are laid out in a line separated by a predetermined distance on the order of 10 - 100 meters). The LIU determines the serial number of the closest two devices (one on each side) and begins a process of beaconing, as in the discovery process. Any slave device that hears the message will change the receiver channel to the index in the Beacon message and come into cycle. However, the Beacon message contains the serial number of the device expected to transition and a pseudo-randomly selected index into the 19-channel cycle-mode table. Once the Beacon message is transmitted by the LIU, it will set its receiver to the same channel specified by the aforementioned index and await a communication from the targeted device. If no slave device matches the serial number, then the process simply repeats at the LIU. Eventually, the targeted device will hear the Beacon message and switch to the appropriate channel from the cycle-mode table. The LIU follows this process for the two nearest devices specified in the provided table, following which, the formed devices repeat the process for one targeted device its immediate downlink neighbor.

Once a device has been formed, it remains in cycle mode until commanded to exit and return to the slave mode (listening only).

The cycle mode is a repeating process whereby uplink/downlink pairs progress through the pseudo-random cycle-mode table alternating an uplink transmission interval and a downlink receiving interval; the complete cycle consumes 16 milliseconds.

In this way, seismic data can be propagated upstream as in a bucket-brigade.

Each interval contains a further division to accommodate downstream communications that are used for acknowledging reception and for propagating commands. This interval is significantly shorter than the upstream interval in order to maximize upstream bandwidth.

The system time is divided into 16ms cycles. This is divided into two 8 ms periods. On one of the 8ms periods a WRU is transmitting Data toward the LIU and on the next 8 ms period it is receiving data to pass on to the LIU on the following period. The LIU always is in the receiving data mode regardless of the 1st or second 8ms period. It does this to receive data from two

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separate subnets. The timing below is described in reference to a WRU in Data Transmit mode and the LIU in receive.

Data Cycle Timing:

```
    □ Command Message (Tx From LIU) = 206.3 μsec
    □ Data Message (Tx From WRU)= 6187.1 μsec
    □ ACK (Tx From LIU)=147.1 μsec
    □ Total = 6540.5 μsec
```

The 206.2 μ s Command message is the worst case time as the system does not always send a actual command. The TX time for the command message when the actual command is null is 130 us. This is the more typical command message length.

The $6187.1~\mu s$ Data message is also a worst case timing . The message is variable size depending on the amount of data to TX at that time.

The same channel is used for the 3 messages listed in this 8 ms time period. The remainder of the 8ms is idle with no transmissions.

Therefore, the worst case time of occupancy of any channel for communicating pair in cycle mode over the specified period in section (iii) above is (see below).

```
P=0.4~s~*~19=7.6~seconds where P is the period within which average channel occupancy <400~ms C=7.6~s/16ms=475 where C is the number of data cycles within P O=(6540.5~\mu s~*475)/19=163.5~ms where O is the average channel occupancy within P
```

The worst case time of occupancy for the WRU communicating in cycle mode over the specified period for one channel is:

```
P=0.4~s~*~19=7.6~seconds where P is the period within which average channel occupancy <400~ms C=7.6~s~/~16~ms=475 where C is the number of data cycles within P O=(6187~\mu s~*~475)/19=154.6~ms where O is the average channel occupancy within P
```

Note that, in cycle-mode, the LIU is always in the receive interval, alternately receiving from one neighbor, then the next. This means that the LIU transmission time is far less than that of the WRU and therefore meets the requirement of section (iii) above. Its worst case time of occupancy is listed below:

```
P=0.4 \text{ s} * 19 = 7.6 \text{ seconds} where P is the period within which average channel occupancy < 400 ms C=7.6 \text{ s}/16 \text{ ms} = 475
```

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where C is the number of data cycles within P
O = (206.3 us * 475)/19 = 5.1 ms
where O is the average channel occupancy within P

Channel Repetition

Note that each WRU functions as a master on one link (downlink) AND a slave on the other link (uplink), whether a downlink WRU exists or not. Every 8 ms the WRU switches between master and slave, and changes channels in the process, executing the 3-message handshake in the uplink and downlink directions. The complete cycle lasts 16 ms. The uplink and downlink connections have different indexes into the hopping table. The downlink index is equal to the uplink index plus one. Both uplink and downlink indexes increment every 8 ms. This results in each connection using alternating even/odd indexes in the pseudo-random hopping table each time the index wraps around. The period of this pattern is thus 16 ms x 19 channels = 304 ms, however channel reuse will be observed at 8 ms x (19 channels -2) = 136 ms, due to the index shift between the uplink and downlink connections. Note that both the uplink and downlink connections each utilize all 19 channels before reuse, so the WRU uses all channels equally on average.

Adaptive Hopping

The RT-System 2 does not perform adaptive frequency hopping. Instead, it has a hop set that was generated as a pseudo-random sequence, each with its own seed.

There is no channel coordination between transmitters in the system. Once two interacting devices establish their beginning channel index, they frequency hop with no regard for what other transmitters are doing. As per the discovery and cycle mode descriptions, the beginning channel index is established in a random way using pseudo-randomly generated indexes as well as pseudo-randomly listening devices.

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10 Antenna Requirements

10.1 Test Procedure

Antenna construction and specifications are reviewed and reported. Parameters with bearing upon relevant rules are evaluated.

10.2 Test Criteria

47 CFR (USA) // IC (Canada)					
Section Reference	Parameter	Date(s)			
15.205 //	Conducted Spurious/Harmonic	2014-05-15			
RSS-Gen Issue 3, 7.1.2	Emissions	2014-05-15			

10.3 Test Results

The EUT was tested with the following antenna:

Antenna Specifications			
Parameter	Observation		
Manufacturer	Comet		
Model	CFA-245-32E		
Туре	Dipole		
Connector	Type 'HPQN' Quick-Connect, based on common N type connector.		
Peak Gain	5.5 dBi		
Installation Method	Professional		

Antenna gain is below the 6 dB criteria for considering antenna gain with power.

The EUT was found to meet the requirements due to the following:

The antenna is required to be professionally installed by Wireless Seismic or its authorized agents. A contract is enforced and covers this requirement.

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Appendix A: Policy, Rationale and Evaluation of EMC Measurement Uncertainty

All uncertainty calculations, estimates and expressions thereof shall be in accordance with NIST policy. Since PTI operates in accordance with NIST (NVLAP) Handbook 150-11: 2007, all instrumentation having an effect on the accuracy or validity of tests shall be periodically calibrated or verified traceable to national standards by a competent calibration laboratory. The certificates of calibration or verification on this instrumentation shall include estimates of uncertainty as required by NIST Handbook 150-11.

1. Rationale and Summary of Expanded Uncertainty.

Each piece of instrumentation at PTI that is used in making measurements for determining conformance to a standard (or limit), shall be assessed to evaluate its contribution to the overall uncertainty of the measurement in which it is used. The assessment of each item will be based on either a type A evaluation or a type B evaluation. Most of the evaluations will be type B, since they will be based on the manufacturer's statements or specifications of the calibration tolerances, or uncertainty will be stated along with a brief rationale for the type of evaluation and the resulting stated uncertainties.

The individual uncertainties included in the combined standard uncertainty for a specific test result will depend on the configuration in which the item of instrumentation is used. The combination will always be based on the law of propagation of uncertainty. Any systematic effects will be accommodated by including their uncertainties, in the calculation of the combined standard uncertainty; except that if the direction and amount of the systematic effect cannot be determined and separated from its uncertainty, the whole effect will be treated as uncertainty and combined along with the other elements of the test setup.

Type A evaluations of standard uncertainty will usually be based on calculating the standard deviation of the mean of a series of independent observations, but may be based on a least-squares curve fit or the analysis of variance for unusual situations. Type B evaluations of standard uncertainty will usually be based on manufacturer's specifications, data provided in calibration reports, and experience. The type of probability distribution used (normal, rectangular, a-priori, or u-shaped) will be stated for each Type B evaluation.

In the evaluation of the uncertainty of each type of measurement, the uncertainty caused by the operator will be estimated. One notable operator contribution to measurement uncertainty is the manipulation of cables to maximize the measured values of radiated emissions. The operator contribution to measurement uncertainty is evaluated by having several operators independently repeat the same test. This results in a Type A evaluation of operator-contributed measurement uncertainty.

A summary of the expanded uncertainties of PTI measurements is shown as Table 1. These are the worst-case uncertainties considering all operative influence factors.

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Table 1: Summary of Measurement Uncertainties for Site 45

Type of Measurement	Frequency Range	Meas. Dist.	Expanded Uncertainty U, dB (k=2)
Mains Conducted Emissions	150 kHz to 30 MHz	N/A	2.9
Telecom Conducted Emissions	150 kHz to 30 MHz	N/A	2.8
Dadiated Emissions	30 to 1000 MHz	10 m	4.8
Radiated Emissions	1 to 18 GHz	3 m	5.7

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End of Report

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