

Intentional Radiator Test Report

Application for Grant of Equipment Authorization

FCC Part 15 Subpart C (15.247)

FCC ID: YJC-RDMERT0

Product Name: Nighthawk RDM960 Personality Module
Model: RDM

APPLICANT: AMI Investments LLC d.b.a Nighthawk
701 Canyon Drive Suite 105
Coppell TX, 75019

TEST SITE(S): National Technical Systems - Plano
1701 E Plano Pkwy #150
Plano, TX 75074

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REVISION HISTORY

Rev#	Date	Comments	Modified By
0	Aug 6, 2014	First Release	Yunus Faziloglu

TABLE OF CONTENTS

REVISION HISTORY	2
TABLE OF CONTENTS	3
SCOPE.....	4
OBJECTIVE	4
STATEMENT OF COMPLIANCE	4
DEVIATIONS FROM THE STANDARDS	5
MODIFICATIONS.....	5
MEASUREMENT UNCERTAINTIES	5
TEST RESULTS SUMMARY	6
EQUIPMENT UNDER TEST (EUT) DETAILS	7
EUT OPERATION.....	8
TEST SITE.....	8
TEST EQUIPMENT.....	8
TEST RESULTS SECTION	9
AC LINE CONDUCTED EMISSIONS	10
20DB BANDWIDTH.....	12
CHANNEL SEPARATION.....	13
NUMBER OF HOPPING CHANNELS	14
DWELL TIME.....	15
PEAK CONDUCTED OUTPUT POWER.....	16
BANDEDGE COMPLIANCE	17
RADIATED SPURIOUS EMISSIONS	18
END OF REPORT.....	20

SCOPE

Tests have been performed on the *AMI Investments LLC* product *Nighthawk RDM960 Personality Module* Model *RDM* to demonstrate compliance with the following rules:

FCC Part 15 Subpart C (15.247)

Conducted and radiated emissions data has been collected, reduced, and analyzed within this report in accordance with measurement guidelines set forth in the following reference standards and as outlined in National Technical Systems – Plano test procedures:

ANSI C63.4-2003

FHSS Test Procedures FCC Public Notice DA 00-705, Mar 2000

Nighthawk RDM960 Personality Module Model RDM was tested inside Itron C2SXD Form 2S Electric Meter to demonstrate compliance with the FCC rules. All intentional radiator parameters were tested in a radiated measurement test setup since an antenna port for direct measurements was not available. During testing Itron C2SXD Form 2S Electric Meter was placed 80cm above the ground plane on a non-conductive RF transparent support structure in upright position as shown in relevant test setup photos. Manufacturer specified this position as the only possible installation condition of the Nighthawk RDM960 Personality Module.

Every practical effort was made to perform an impartial test using appropriate test equipment of known calibration. All pertinent factors have been applied to reach the determination of compliance.

OBJECTIVE

The primary objective of the manufacturer is to demonstrate compliance with the regulations outlined in the previous section. This report is intended to support a grant of equipment authorization application of the Nighthawk RDM960 Personality Module as a “Limited Modular Approval” to be used inside Itron C2SXD Form 2S Electric Meter.

STATEMENT OF COMPLIANCE

Nighthawk RDM960 Personality Module complied with the applicable requirement listed under the following FCC rules as a 900MHz frequency hopping spread spectrum transmitter:

FCC Part 15 Subpart C (15.247)

Testing was performed only on Nighthawk RDM960 Personality Module Model RDM when housed inside Itron C2SXD Form 2S Electric Meter as described above. Results only apply to that configuration. No other model variations or configurations were specified.

Maintenance of compliance is the responsibility of the manufacturer. Any modification to the product should be assessed to ensure compliance has been maintained.

Drew Caruth was present during all testing to represent the manufacturer.

DEVIATIONS FROM THE STANDARDS

During testing there were no deviations from the regulatory rules and test procedures listed above.

MODIFICATIONS

None

MEASUREMENT UNCERTAINTIES

The measurement of uncertainty is not included with the data in this test report.

TEST RESULTS SUMMARY

FCC Rule Part	Description	Measured Value / Comments	Limit / Requirement	Result
15.203	Antenna connector	Folded quarter-wave monopole printed circuit trace	Unique antenna connector or permanently attached antenna	Complies
15.207	AC Line conducted emissions	Lowest passing margin -19.271dB	As specified in 15.207(a)	Complies
15.215(c)	Frequency band of operation	910.0MHz - 919.8MHz	Within 902MHz – 928MHz	Complies
15.247(a)(1)	20dB Bandwidth	111 kHz	Channel spacing > 20dB bandwidth / 25kHz	Complies
	Channel Separation	200 kHz		Complies
15.247(a)(1)(i)	Number of Channels	50	50 or more	Complies
15.247(a)(1)(i)	Channel Dwell Time	68.7 milliseconds	< 0.4 seconds within a 20 second period	Complies
15.247(b)(2)	Conducted Output Power	0.008W EIRP = 0.025W	Conducted < 1.0W EIRP < 4.0W	Complies
15.247(d)	Antenna Port Spurious Emissions 30MHz – 9.28 GHz	Antenna port was not available	< -20dBc	N/A
15.247(d) 15.209	Radiated Spurious Emissions 30MHz – 9.28 GHz	50.9dBuV/m at 3m	15.209(a) in restricted bands, all others < -20dBc	Complies

Notes:

- Antenna gain is declared as maximum 5.0dBi by the manufacturer.
- Compliance to frequency hopping spread spectrum requirements of 15.247(a)(1), 15.247(g) and 15.247(h) are described by the manufacturer in the Operational Description exhibit.
- 15.247(i) RF exposure requirements are addressed in a separate exhibit.
- A separate test report has been issued to demonstrate compliance with FCC 15B unintentional emissions and receiver spurious emissions requirements.

EQUIPMENT UNDER TEST (EUT) DETAILS

Nighthawk RDM960 Personality Module Model RDM provides wireless capabilities to the Itron C2SXD Form 2S Electric Meter. The RDM960 includes an onboard ERT radio that operates in the 910.0MHz – 919.8MHz frequency range as a frequency hopper for drive-by read. It transmits a standard consumption message (SCM) that can be read by a utility's existing meter reading equipment. It employs OOK modulation, uses 50 channels and transmits at a data rate of 16.384kbps. In addition, RDM960 includes two previously certified radios; a Novatel HS 3001 cell modem (FCC ID MIVCNN0301) and a Synapse SM200 RF engine (FCC ID U9O-SM200). The cell modem transmits metrology data over the cellular network and receives commands such as remote connect/disconnect. The RF engine is a 2.4 GHz band transceiver for mesh networking applications.

Configuration supplied for testing was as follows:

Description	Part/Model Number	Revision	Serial Number	Location
Meter Box	N/A	N/A	N/A	Top-level assembly
Itron C2SXD Form 2S Electric Meter	G981143	N/A	69290356	Mounted in meter box
Nighthawk RDM960 Personality Module	RDM	3.01	0004	Installed in meter
ERT Radio	CC1101	N/A	N/A	On RDM960 PCB, top side
Novatel Cell Modem	HS 3001	N/A	N/A	On RDM960 PCB, top side
Synapse RF Engine	SM200	N/A	N/A	On RDM960 PCB, top side

Host (Itron C2SXD Form 2S Electric Meter) interface ports were as follows:

Port	Connected To	Cable(s)		
		Description	Shielded or Unshielded	Length(m)
Power	208VAC/60Hz Mains	AC Power	Unshielded	6ft
Serial Interface	Support Laptop PC	Optical/USB	Unshielded	3ft

List of support equipment used during testing was as follows:

Company	Model	Description	Serial Number	FCC ID
Lenovo	G550 2958	Laptop PC	CBU2833007	Contains FCC ID: QDS-BRCM1028

Support laptop PC was used only to put the RDM960 in specific test modes. It was disconnected during measurements.

EUT OPERATION

During testing, ERT radio was transmitting at its highest power level at full data rate. Hopping function could be enabled or disabled and 3 different channels (low, middle and top) could be selected for continuous transmission as needed.

TEST SITE

Final test measurements were taken at the test sites listed below.

Site	Registration Numbers		Location
	FCC	Canada	
Chamber 1	A2LA Accredited Designation Number US1077	IC 4319A	1701 E Plano Pkwy #150 Plano, TX 75074.

ANSI C63.4 recommends that ambient noise at the test site be at least 6 dB below the allowable limits. Ambient levels are below this requirement. The test site(s) contain separate areas for radiated and conducted emissions testing. Considerable engineering effort has been expended to ensure that the facilities conform to all pertinent requirements of ANSI C63.4.

TEST EQUIPMENT

NTS Equipment #	Description	Manufacturer	Model	Calibration Duration	Calibration Due Date
E1529P	PSA	Agilent	E4446A	12 Months	2/14/2015
E1554P	PreAmp (1GHz-40GHz)	MITEQ	JS32-00104000-62-5P	12 Months	5/14/2015
E1524P	Biconilog Antenna (30MHz-1GHz)	ETS Lindgren	3142D	12 Months	3/19/2015
E1149P	Horn Antenna (1GHz-18GHz)	EMCO	3115	12 Months	11/25/2014
E1068P	Horn Antenna (18GHz-40GHz)	EMCO	3116	12 Months	5/15/2015
E1354P	LISN	Rohde&Schwarz	ESH3-Z5	12 Months	10/15/2014
E1525P	Transient Limiter	Hameg	HZ560	12 Months	12/10/2014

Test Results Section

AC Line Conducted Emissions

Regulatory Rule / Standard	CFR Title 47 §15.207		
Standard / Method of Measurement	ANSI C63.4-2003 Methods of Measurement of Radio Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz		
Specifications	Frequency (MHz)	Quasi-Peak Limit (dBuV)	Average Limit (dBuV)
	0.15 – 0.5	66 to 56*	56 to 46*
	0.5 – 5.0	56	46
	5.0 – 30.0	60	50
	* Decreases with the logarithm of the frequency		
Deviations From Method of Measurement	None		
Tested By	Yunus Faziloglu		
Date	Jul-17-2014		
Test Result	Complies – Tabular data shown below		

EUT transmitting on low channel – Line

Frequency (MHz)	QP Reading (dBuV)	QP Limit (dBuV)	QP Margin (dB)	AV Reading (dBuV)	AV Limit (dBuV)	AV Margin (dB)
0.153	29.365	65.913	-36.548	19.388	55.913	-36.526
0.357	21.028	60.083	-39.055	12.735	50.083	-37.348
0.542	19.784	56	-36.216	15.169	46	-30.831
0.986	20.797	56	-35.203	15.858	46	-30.142
1.146	21.234	56	-34.766	15.97	46	-30.03
1.263	21.307	56	-34.693	16.163	46	-29.837

EUT transmitting on low channel – Neutral

Frequency (MHz)	QP Reading (dBuV)	QP Limit (dBuV)	QP Margin (dB)	AV Reading (dBuV)	AV Limit (dBuV)	AV Margin (dB)
26.556	33.363	60	-26.637	28.11	50	-21.89
27.157	35.03	60	-24.97	30.392	50	-19.608
27.302	33.792	60	-26.208	26.37	50	-23.63
27.501	35.099	60	-24.901	28.66	50	-21.34
27.606	34.541	60	-25.459	28.771	50	-21.229
28.009	31.432	60	-28.568	24.553	50	-25.447

EUT transmitting on high channel - Line

Frequency (MHz)	QP Reading (dBuV)	QP Limit (dBuV)	QP Margin (dB)	AV Reading (dBuV)	AV Limit (dBuV)	AV Margin (dB)
0.161	29.969	65.678	-35.709	17.767	55.678	-37.911
0.408	19.273	58.615	-39.343	12.062	48.615	-36.553
0.533	22.138	56	-33.862	17.434	46	-28.566
0.643	19.849	56	-36.151	14.808	46	-31.192

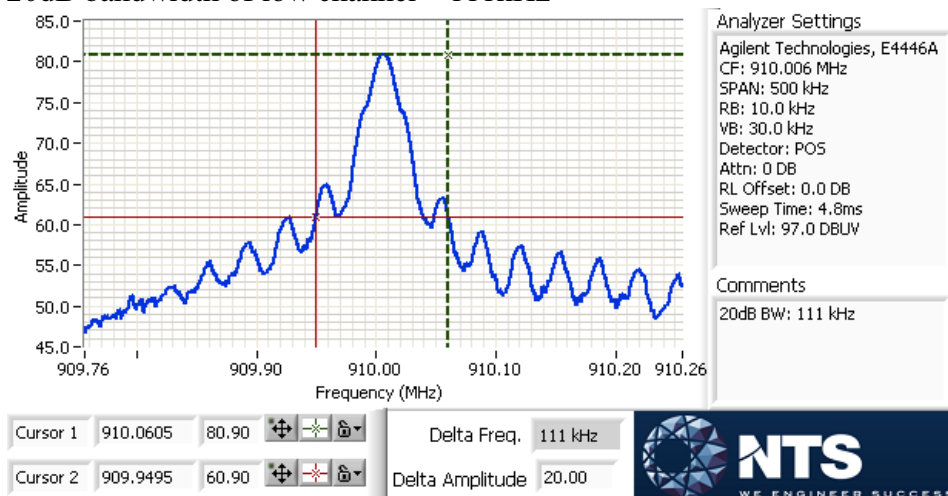
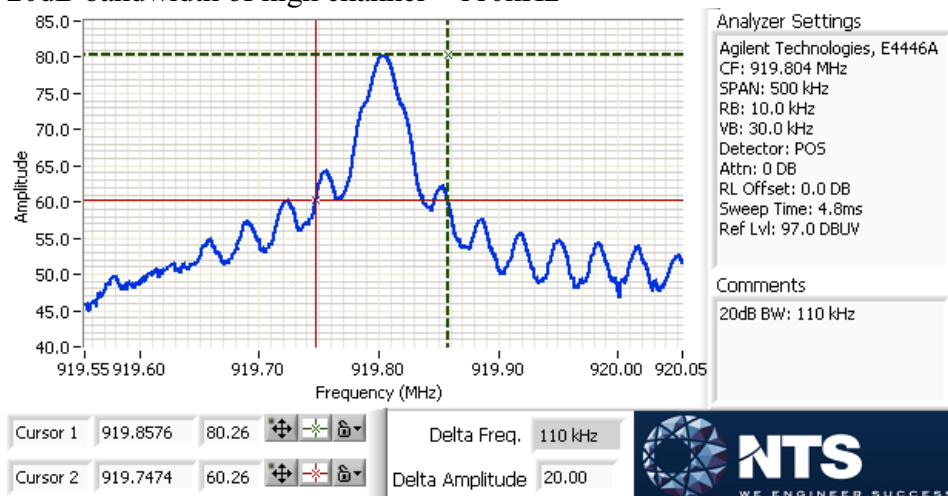
1.078	21.44	56	-34.56	16.083	46	-29.917
1.261	20.401	56	-35.599	15.259	46	-30.741

EUT transmitting on high channel - Neutral

Frequency (MHz)	QP Reading (dBuV)	QP Limit (dBuV)	QP Margin (dB)	AV Reading (dBuV)	AV Limit (dBuV)	AV Margin (dB)
26.327	31.69	60	-28.31	24.854	50	-25.146
26.475	33.14	60	-26.86	27.762	50	-22.238
26.979	35.586	60	-24.414	29.667	50	-20.333
27.124	35.434	60	-24.566	30.729	50	-19.271
27.422	34.305	60	-25.695	27.538	50	-22.462
27.564	34.853	60	-25.147	29.187	50	-20.813

20dB Bandwidth

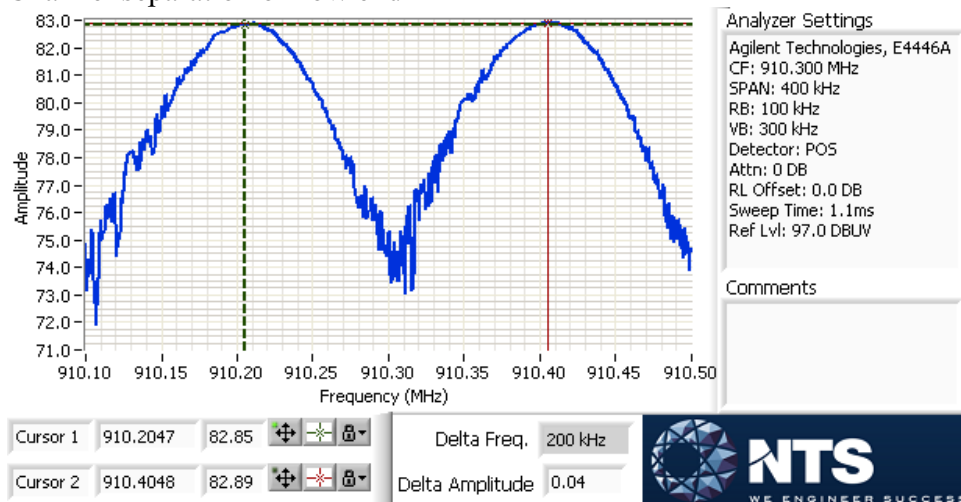
Regulatory Rule / Standard	CFR Title 47 §15.247(a)(1)(i)				
Standard / Method of Measurement	FHSS Test Procedures FCC Public Notice DA 00-705, Mar 2000				
Specifications	20dB bandwidth shall not exceed 500kHz				
Deviations From Method of Measurement	None				
Tested By	Yunus Faziloglu				
Date	Jul-16-2014				
Test Result	Channel	Frequency (MHz)	20dB Bandwidth (kHz)	Limit (kHz)	Verdict
	Low	910.0	111	< 500kHz	Complies
	High	919.8	110	< 500kHz	Complies
	Corresponding plots shown below				

20dB bandwidth of low channel – 111kHz**20dB bandwidth of high channel – 110kHz**

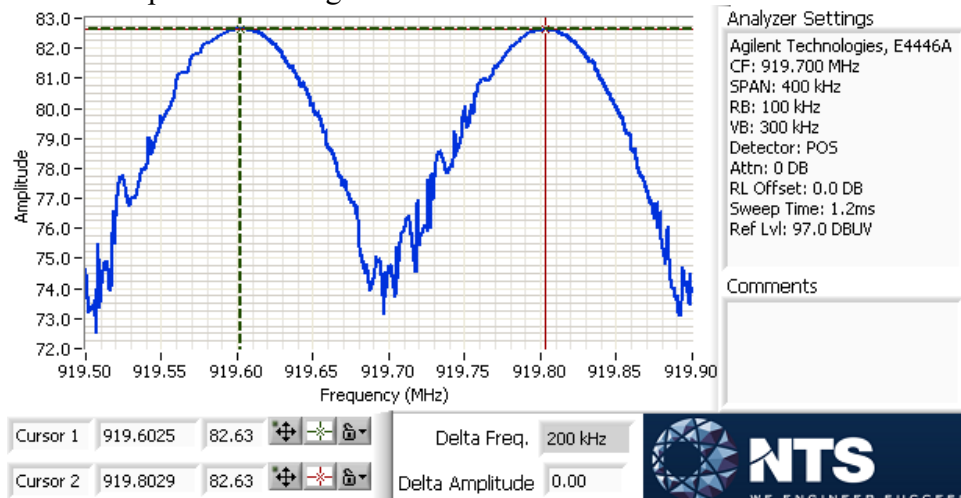
Channel Separation

Regulatory Rule / Standard	CFR Title 47 §15.247(a)(1)			
Standard / Method of Measurement	FHSS Test Procedures FCC Public Notice DA 00-705, Mar 2000			
Specifications	Minimum of 25kHz or the 20dB bandwidth, whichever is greater			
Deviations From Method of Measurement	None			
Tested By	Yunus Faziloglu			
Date	Jul-16-2014			
Test Result	Segment	20dB Bandwidth (kHz)	Limit (kHz)	Verdict
	Low End	200	> 111 kHz	Complies
	High End	200	> 111 kHz	Complies
	Corresponding plots shown below			

Channel separation on low end



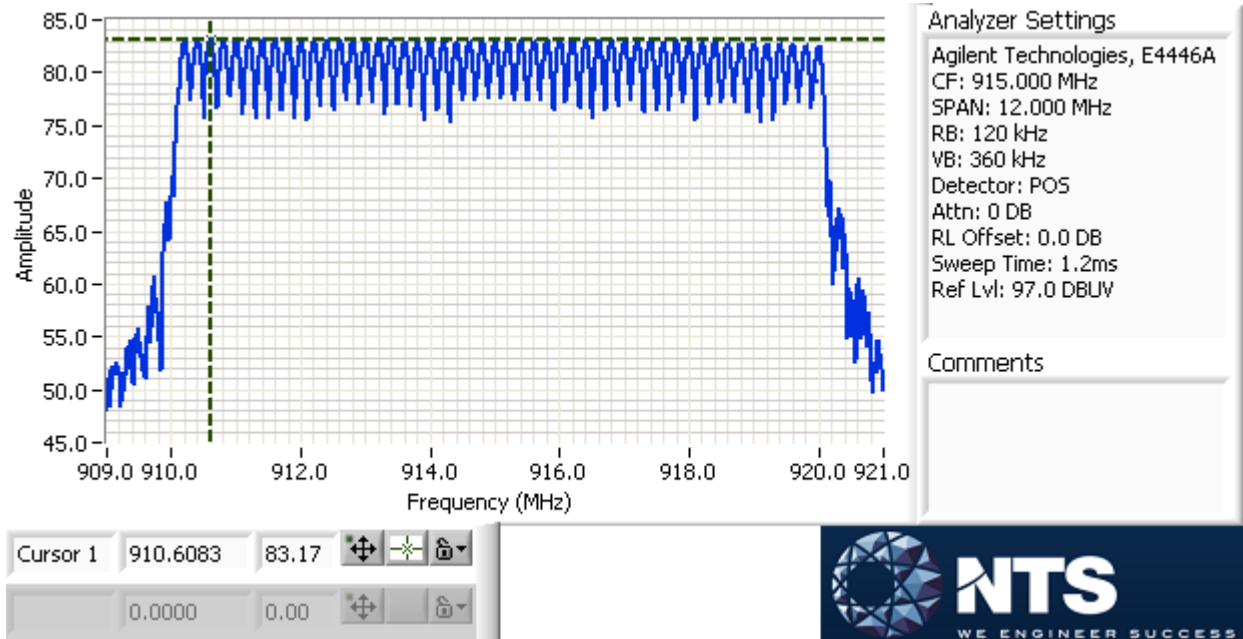
Channel separation on high end



Number of Hopping Channels

Regulatory Rule / Standard	CFR Title 47 §15.247(a)(1)(i)		
Standard / Method of Measurement	FHSS Test Procedures FCC Public Notice DA 00-705, Mar 2000		
Specifications	At least 50 hopping frequencies since the 20dB bandwidth is less than 250kHz		
Deviations From Method of Measurement	None		
Tested By	Yunus Faziloglu		
Date	Jul-16-2014		
Test Result	Number of hopping channels	Limit	Verdict
	50	At least 50	Complies
Corresponding plot shown below			

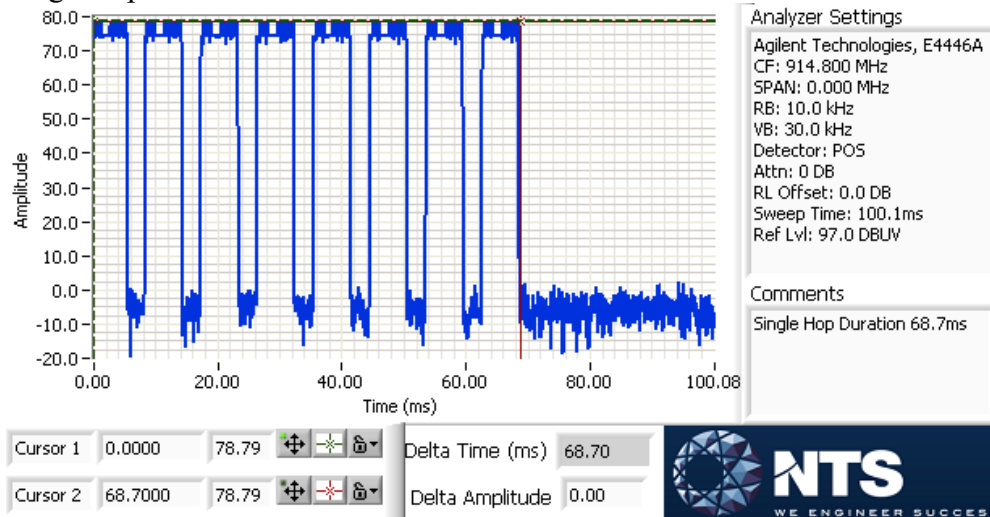
50 channels



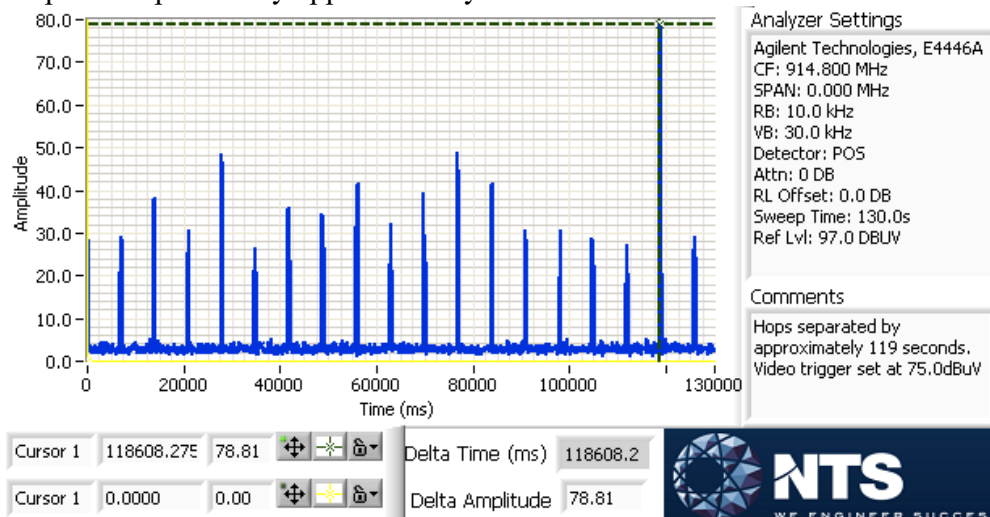
Dwell Time

Regulatory Rule / Standard	CFR Title 47 §15.247(a)(1)(i)		
Standard / Method of Measurement	FHSS Test Procedures FCC Public Notice DA 00-705, Mar 2000		
Specifications	The average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second time period since the 20dB bandwidth is less than 250kHz		
Deviations From Method of Measurement	None		
Tested By	Yunus Faziloglu		
Date	Jul-16-2014		
Test Result	Total dwell time within a 20 second period	Limit	Verdict
	68.7 milliseconds	0.4 seconds	Complies
	Corresponding plots and calculation shown below		

Single hop duration is 68.7 milliseconds



Hops are separated by approximately 119 seconds



Since it takes approximately 119 seconds for the hop to repeat, the total time of occupancy within a 20 second period is 68.7 milliseconds.

Peak Conducted Output Power

Regulatory Rule / Standard	CFR Title 47 §15.247(b)(2)
Standard / Method of Measurement	FHSS Test Procedures FCC Public Notice DA 00-705, Mar 2000
Specifications	1.0W peak conducted and 4.0W EIRP since the EUT employs at least 50 hopping channels
Deviations From Method of Measurement	None
Tested By	Yunus Faziloglu
Date	Jul-16-2014
Test Result	Complies - Tabular data shown below

Meas Detector	Meas Distance	Antenna Polarity	Frequency (MHz)	Raw Reading (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Reading (dBuV/m)	EIRP (dBm)	Declared Antenna Gain of EUT (dBi)	Peak Conducted Output Power (W)
Peak	3m	H	910.0	79	24.2	1.86	105.06	9.83	5.0	0.003
Peak	3m	V	910.0	83.1	24.2	1.86	109.16	13.93	5.0	0.008
Peak	3m	H	919.8	76.9	24.6	1.90	103.4	8.17	5.0	0.002
Peak	3m	V	919.8	82.4	24.6	1.90	108.9	13.67	5.0	0.007

Antenna is a “folded quarter-wave monopole printed circuit trace” with a declared gain of 5.0dBi

Measurement System Settings:

Span = 5MHz, RBW = 300kHz, VBW = 910kHz, Peak, Max-hold, Auto sweep

Calculations:

Corrected Reading (dBuV/m) = Raw Reading (dBuV) + Antenna Factor (dB/m) + Cable Loss (dB)

EIRP(dBm) = Corrected Reading (dBuV/m) – 104.77 + 20log(3)

Peak Conducted Output Power (dBm) = EIRP (dBm) – Declared Antenna Gain (dBi)

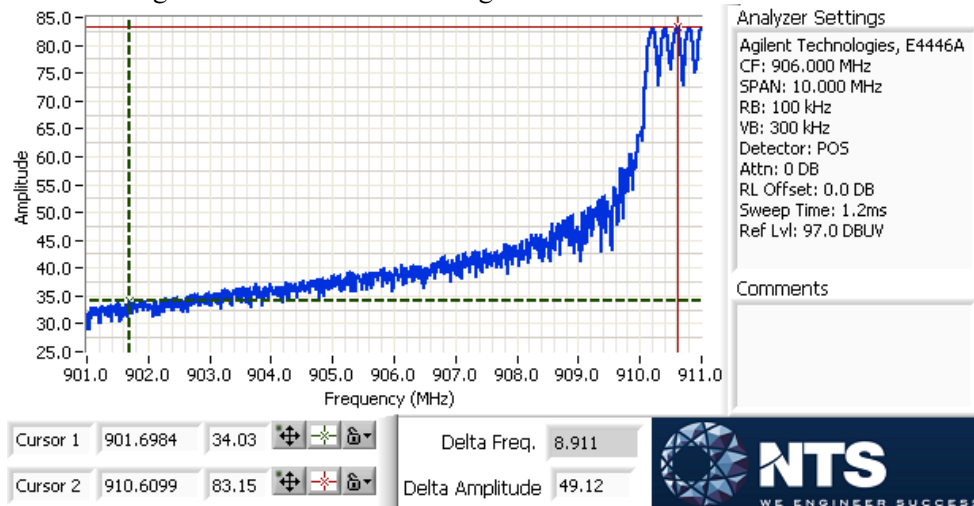
Peak Conducted Output Power (mW) = $10^{(\text{Peak Conducted Output Power (dBm)} / 10)}$

Peak Conducted Output Power (W) = Peak Conducted Output Power (mW) / 1000

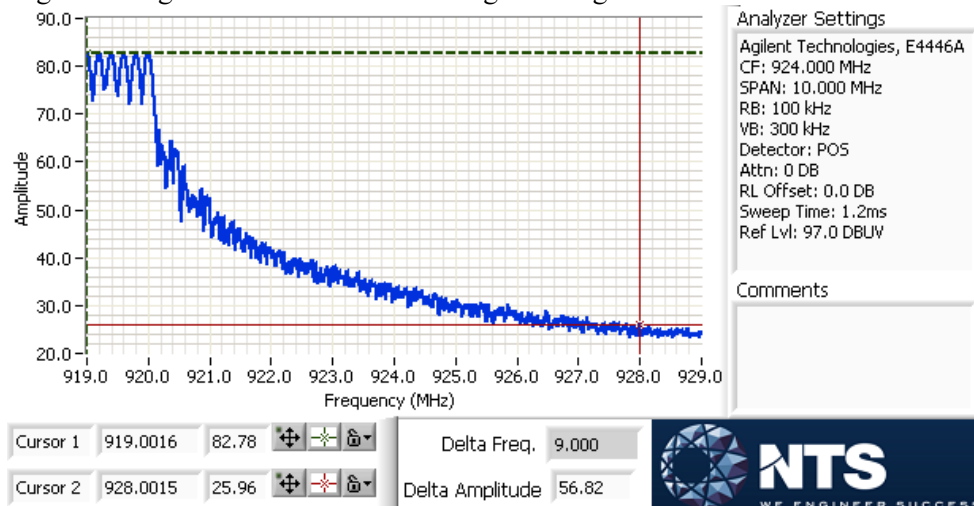
Bandedge Compliance

Regulatory Rule / Standard	CFR Title 47 §15.247(d)				
Standard / Method of Measurement	FHSS Test Procedures FCC Public Notice DA 00-705, Mar 2000				
Specifications	20dB below the fundamental in any 100kHz bandwidth				
Deviations From Method of Measurement	None				
Tested By	Yunus Faziloglu				
Date	Jul-16-2014				
Test Result	Channel	Bandedge Frequency (MHz)	Delta at Bandedge (dBc)	Limit	Verdict
	Low	902.0	-49.1	< -20dBc	Complies
	High	928.0	-56.8	< -20dBc	Complies
	Corresponding plots shown below				

Low bandedge when EUT is transmitting at its lowest channel



High bandedge when EUT is transmitting at its highest channel



Radiated Spurious Emissions

Regulatory Rule / Standard	CFR Title 47 §15.247(d) and §15.209(a)
Standard / Method of Measurement	FHSS Test Procedures FCC Public Notice DA 00-705, Mar 2000
Specifications	20dB below the fundamental in any 100kHz bandwidth in non-restricted bands and 15.209(a) limits in all restricted bands as specified in 15.205(a)
Deviations From Method of Measurement	None
Tested By	Yunus Faziloglu
Date	Jul-17-2014
Test Result	Complies - Tabular data shown below

All spurious emissions in 30MHz-1GHz range were at noise floor level based on pre-scan results. The noise floor of the measurement system in this frequency range was below the generic 15.209(a) limits.

In 1GHz-10GHz range all spurious emissions other than the harmonics listed below were at noise floor level. The noise floor of the measurement system in this frequency range was below the generic 15.209(a) limits as well.

Measurement System Settings:

30MHz – 1GHz: Peak, RBW = 100kHz, VBW = 300kHz

1GHz – 10GHz: Peak, RBW = 1MHz, VBW = 3MHz (VBW=10Hz for Average)

EUT transmitting on its lowest channel at 910.0MHz

Polarity / Detector	Freq (MHz)	Raw (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Gain (dB)	Filter Loss (dB)	Corrected (dBuV/m) at 3m	Limit (dBuV/m) at 3m	Margin (dB)
V-Peak	1820	76	26.9	4.1	-48.8	1.6	59.8	74	-14.2
V-Av	1820	53.6	26.9	4.1	-48.8	1.6	37.4	54	-16.6
H-Peak	1820	72.1	26.9	4.1	-48.8	1.6	55.9	74	-18.1
H-Av	1820	51.6	26.9	4.1	-48.8	1.6	35.4	54	-18.6
V-Peak	2730	54.8	28.8	4.9	-48	1.6	42.1	54	-11.9
H-Peak	2730	53.2	28.8	4.9	-48	1.6	40.5	54	-13.5
V-Peak	3640	52.4	31.6	5.7	-47	1.6	44.3	54	-9.7
H-Peak	3640	50.9	31.6	5.7	-47	1.6	42.8	54	-11.2
V-Peak	4550	49.9	32.3	6.5	-46.6	1.6	43.7	54	-10.3
H-Peak	4550	48.1	32.3	6.5	-46.6	1.6	41.9	54	-12.1
V-Peak	5460	49.3	34	6.9	-46	1.6	45.8	54	-8.2
H-Peak	5460	51	34	6.9	-46	1.6	47.5	54	-6.5
V-Peak	6370	48	34.5	7.3	-45.7	1.6	45.7	54	-8.3
H-Peak	6370	48.5	34.5	7.3	-45.7	1.6	46.2	54	-7.8

Corrected Reading (dBuV/m) = Raw Reading (dBuV) + Antenna Factor (dB/m) + Cable Loss (dB) + Preamp Gain (dB) + Filter Loss (dB)

Margin (dB) = Corrected Reading (dBuV/m) – Limit (dBuV/m)

Negative margin indicates a passing result

EUT transmitting on its highest channel at 919.8MHz

Polarity / Detector	Freq (MHz)	Raw (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamplifier Gain (dB)	Filter Loss (dB)	Corrected (dBuV/m) at 3m	Limit (dBuV/m) at 3m	Margin (dB)
V-Peak	1839.6	70.2	27	4.1	-48.8	1.6	54.1	74	-19.9
V-Av	1839.6	50.8	27	4.1	-48.8	1.6	34.7	54	-19.3
H-Peak	1839.6	66.7	27	4.1	-48.8	1.6	50.6	74	-23.4
H-Av	1839.6	46.2	27	4.1	-48.8	1.6	30.1	54	-23.9
V-Peak	2759.4	52.6	28.8	4.9	-48	1.6	39.9	54	-14.1
H-Peak	2759.4	50.6	28.8	4.9	-48	1.6	37.9	54	-16.1
V-Peak	3679.2	50.1	31.7	5.7	-47	1.6	42.1	54	-11.9
H-Peak	3679.2	50.3	31.7	5.7	-47	1.6	42.3	54	-11.7
V-Peak	4599	50.8	32.4	6.5	-46.5	1.6	44.8	54	-9.2
H-Peak	4599	52.2	32.4	6.5	-46.5	1.6	46.2	54	-7.8
V-Peak	5518.8	52.4	34	6.9	-46.1	1.6	48.8	54	-5.2
H-Peak	5518.8	54.1	34	6.9	-46.1	1.6	50.5	54	-3.5
V-Peak	6438.6	53.1	34.4	7.3	-45.5	1.6	50.9	54	-3.1
H-Peak	6438.6	52	34.4	7.3	-45.5	1.6	49.8	54	-4.2

Corrected Reading (dBuV/m) = Raw Reading (dBuV) + Antenna Factor (dB/m) + Cable Loss (dB) + Preamp Gain (dB) + Filter Loss (dB)

Margin (dB) = Corrected Reading (dBuV/m) – Limit (dBuV/m)

Negative margin indicates a passing result

End of Report

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