Compliance Testing, LLC
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EMI, EMC, RF Testing Experts Since 1963

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Test Report

Prepared for: Packet Power, LLC

Model: P5T1

Description: Smart Power Cable

Serial Number: N/A

FCC ID: WCGP5T1
IC: 8751A-P5T1

To

FCC Part 15.247 FHSS

Date of Issue: January 30, 2015

On the behalf of the applicant:	**Packet Power, LLC** **2716 Summer St NE** **Minneapolis, MN 55413**
Attention of:	**Steve VanTassel, CEO** **Ph: (612) 396-8704** **E-mail: steve@packetpower.com**

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Project No: p14b0018

Alex Macon
Project Test Engineer

Test Report Revision History

Revision	Date	Revised By	Reason for Revision
1.0	December 15, 2014	Alex Macon	Original Document
2.0	January 30, 2015	Alex Macon	Added BW Plots and Timing explanation

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ILAC / A2LA

Compliance Testing, LLC, has been accredited in accordance with the recognized International Standard ISO/IEC 17025:2005. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to the joint ISO-ILAC-IAF Communiqué dated January 2009).

The tests results contained within this test report all fall within our scope of accreditation, unless noted in the table below.

Please refer to http://www.compliancetesting.com/labscope.html for current scope of accreditation.

Testing Certificate Number: **2152.01**

FCC Site Reg. #349717

IC Site Reg. #2044A-2

Non-accredited tests contained in this report:

N/A

The applicant has been cautioned as to the following

15.21 - Information to User

The user's manual or instruction manual for an intentional radiator shall caution the user that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

15.27(a) - Special Accessories

Equipment marketed to a consumer must be capable of complying with the necessary regulations in the configuration in which the equipment is marketed. Where special accessories, such as shielded cables and/or special connectors are required to enable an unintentional or intentional radiator to comply with the emission limits in this part, the equipment must be marketed with, i.e. shipped and sold with, those special accessories. However, in lieu of shipping or packaging the special accessories with the unintentional or intentional radiator, the responsible party may employ other methods of ensuring that the special accessories are provided to the consumer, without an additional charge.

Information detailing any alternative method used to supply the special accessories for a grant of equipment authorization or retained in the verification records, as appropriate. The party responsible for the equipment, as detailed in 2.909 of this chapter, shall ensure that these special accessories are provided with the equipment. The instruction manual for such devices shall include appropriate instructions on the first page of text concerned with the installation of the device that these special accessories must be used with the device. It is the responsibility of the user to use the needed special accessories supplied with the equipment.

Standard Test Conditions and Engineering Practices

All tests and measurement data shown were performed in accordance with FCC Rules and Regulations, Volume II; Part 2 and the following individual Parts: 15.247 Operation within bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz.

Except as noted herein, the following conditions and procedures were observed during the testing:

In accordance with ANSI C63.4-2009, ANSI C63.10-2009, FCC DA 00-705, and unless otherwise indicated in the specific measurement results, the ambient temperature of the actual EUT was maintained within the range of 10 to 40C (50 to 104F) unless the particular equipment requirements specified testing over a different temperature range. Also, unless otherwise indicated, the humidity levels were in the range of 10% to 90% relative humidity.

Environmental Conditions		
Temperature (°C)	**Humidity (%)**	**Pressure (mbar)**
24.3 – 21.7	36.4 – 41.9	967.1 – 971.2

Measurement results, unless otherwise noted, are worst case measurements.

Test Results Summary

Specification	Test Name	Pass, Fail, N/A	Comments
15.247(b)	Peak Output Power	Pass	
15.247(d)	Conducted Spurious Emissions	N/A	Device incorporates an integral antenna.
15.247(d), 15.209(a), 15.205	Radiated Spurious Emissions	Pass	
15.247(d), 15.209(a), 15.205	Emissions At Band Edges	Pass	
15.247(a)	Occupied Bandwidth	Pass	
15.247(a)	Dwell Time	Pass	
15.247(a)	Number of Hopping Channels	Pass	
15.207	A/C Powerline Conducted Emissions	Pass	

EUT Description
Model: P5T1
Description: Smart Power Cable
Software: NMX Packet Power URL
Serial Number: N/A
Additional Information:
The EUT is an inline voltage and current meter which incorporates a 2.4 GHz radio with an integral antenna.

EUT Operation during Tests
EUT was placed in test modes using the NMX PacketPower URL paired with the node configurator.

15.203: Antenna Requirement:

X	The antenna is permanently attached to the EUT
	The antenna uses a unique coupling
	The EUT must be professionally installed
	The antenna requirement does not apply

Accessories:

Qty	Description	Manufacturer	Model	S/N
1	Node Configurator	Packet Power	63E1-0200-2014-001D	N/A

Cables: None

Modifications: None

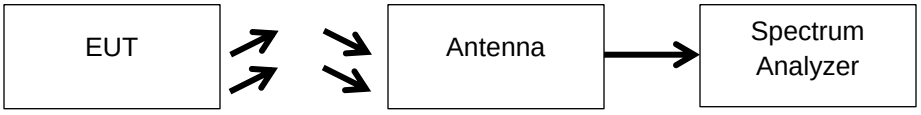
Peak Output Power

Name of Test:	Peak Output Power	**Engineer:** Alex Macon
Test Equipment Utilized:	i00103, i00379, i00428	**Test Date:** 12/3/14

Test Procedure

The EUT was tested in a semi-anechoic chamber set 3m from the receiving antenna. A spectrum analyzer was used to verify that the EUT met the requirements. The antenna and cable correction factors were summed and entered into the spectrum analyzer as an offset to ensure accurate readings. The EUT incorporates a 9dBi antenna.

Test Setup



Transmitter Peak Output Power

Tuned Frequency (MHz)	Recorded Measurement	Specification Limit	Result
2401	.458 mW	125 mW	Pass
2431	.366 mW	125 mW	Pass
2464	.275 mW	125 mW	Pass

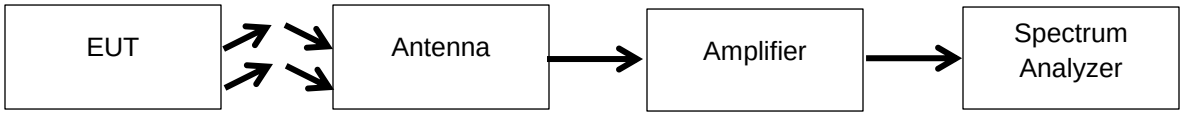
Radiated Spurious Emissions

Name of Test:	Radiated Spurious Emissions	**Engineer:** Alex Macon
Test Equipment Utilized:	i00271, i00273, i00349, i00379, i00428	**Test Date:** 12/10/14

Test Procedure

The EUT was tested in a semi-anechoic chamber set 3m from the receiving antenna. A spectrum analyzer was used to verify that the EUT met the requirements for Radiated Spurious Emissions. The antenna and cable correction factors were summed with the amplifier gain and entered into the spectrum analyzer as an offset to ensure accurate readings. The spectrum for each tuned frequency was examined to the 10th harmonic.

Test Setup



Detector Settings	RBW	VBW
Peak	1 MHz	3 MHz
Average	1 MHz	30 Hz

Radiated Spurious Emissions

Tuned Frequency (MHz)	Emission Frequency (MHz)	Peak Monitored Level (dBuV/m)	Peak Limit (dBuV/m)	Average Monitored Level (dBuV/m)	Average Limit (dBuV/m)	Result
2401	4782.5	45.8	74.0	Note 1	54.0	Pass
2401	7205.0	39.4	74.0	Note 1	54.0	Pass
2431	4861.9	53.5	74.0	Note 1	54.0	Pass
2464	4910.0	55.21	74.0	36.34	54.0	Pass
2464	7375.0	41.62	74.0	Note 1	54.0	Pass
2464	9840.0	45.18	74.0	Note 1	54.0	Pass

Note 1: Peak emission is below Average Limit.
No other emissions were detectable. All emissions were greater than 20dB below their respective limit.

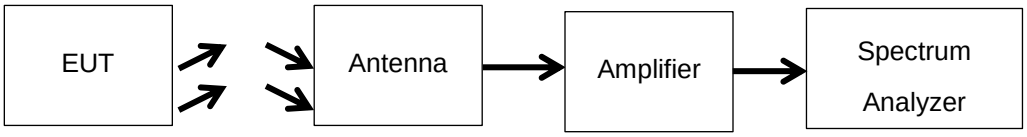
Emissions at Band Edges

Name of Test:	Emissions at Band Edges	**Engineer:** Alex Macon
Test Equipment Utilized:	i00103, i00379, i00428	**Test Date:**12/3/14

Test Procedure

The EUT was tested in a 3 meter semi-anechoic chamber. A spectrum analyzer was used to verify that the EUT met the requirements for band edge with both peak and average measurements. The cable and transducer correction factors were input into the analyzer as a reference level offset to ensure accurate readings.

Test Setup

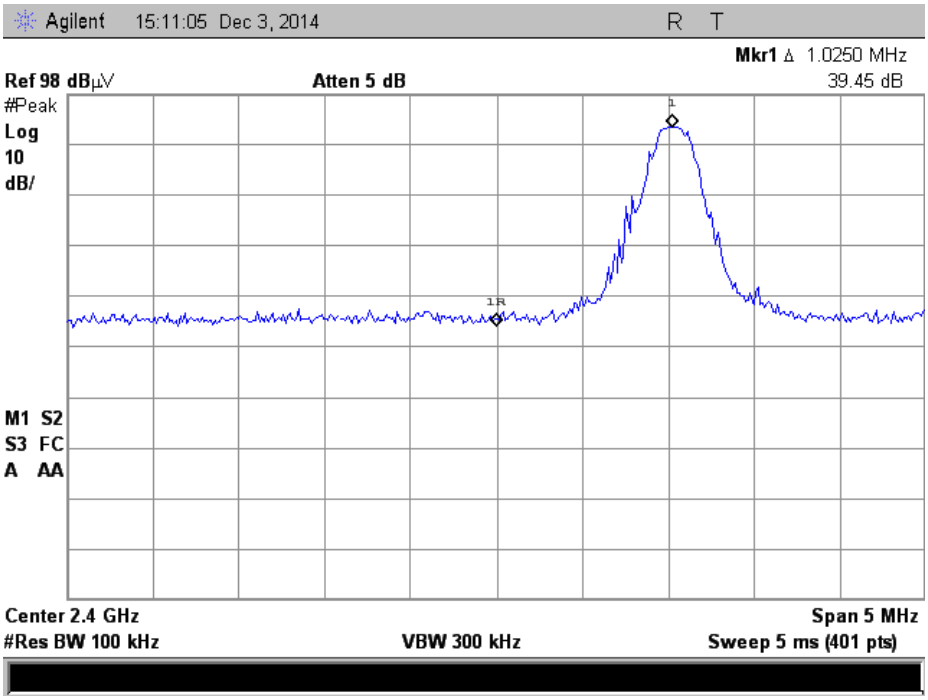


Band Edge Emissions Summary

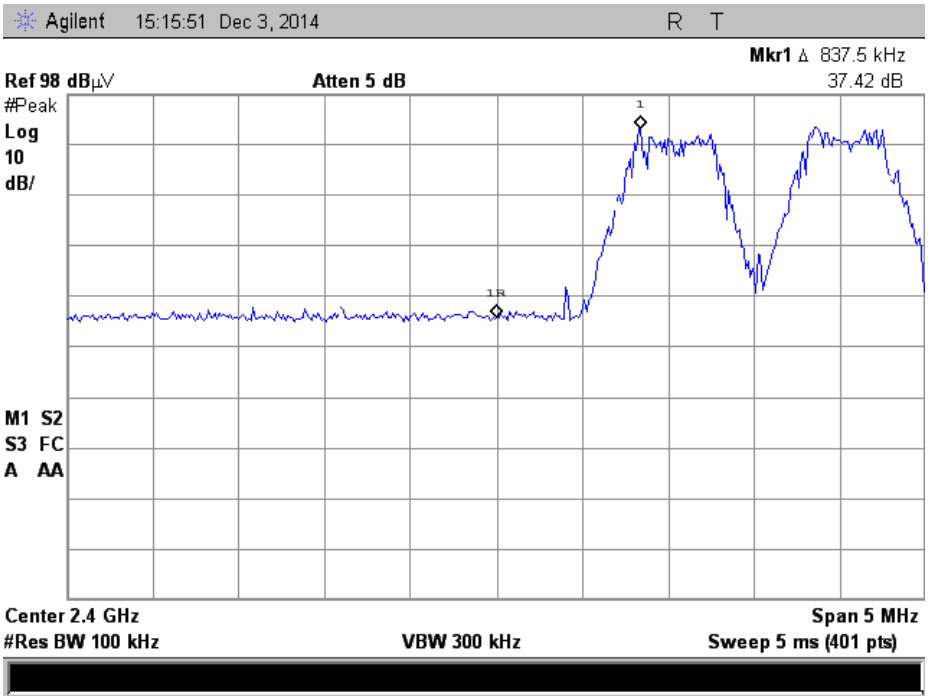
Tuned Frequency (MHz)	Emission Frequency (MHz)	Monitored Level	Detector	Limit	Result
2401	2400	-37.42 dBc	Peak	-20 dBc	Pass
2464	2483.5	-37.63 dBc	Peak	-20 dBc	Pass

Band Edge 2400 MHz

2401 MHz CW

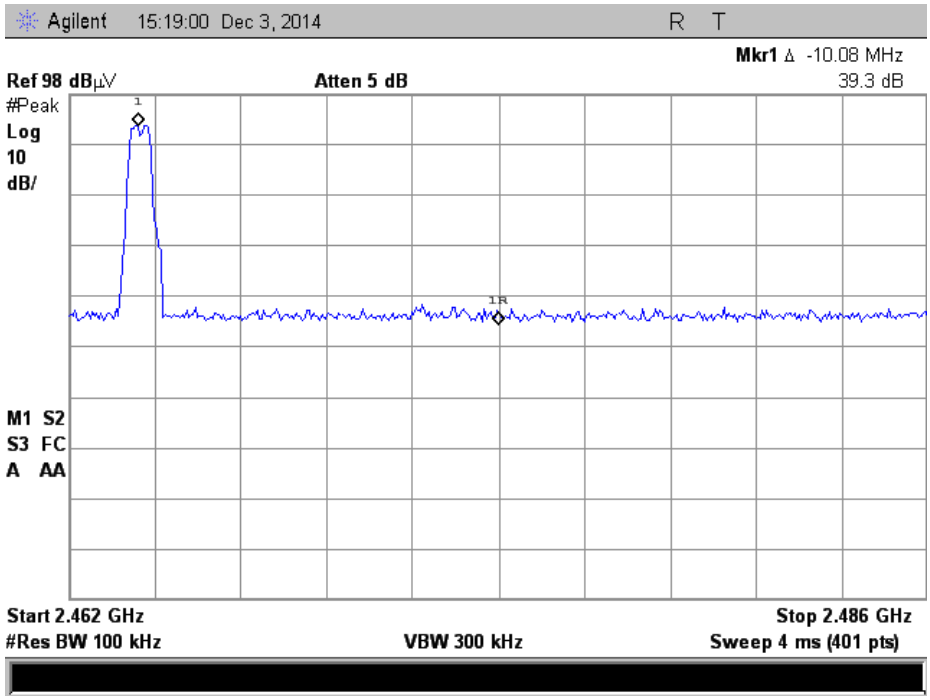


2401 MHz Hopping

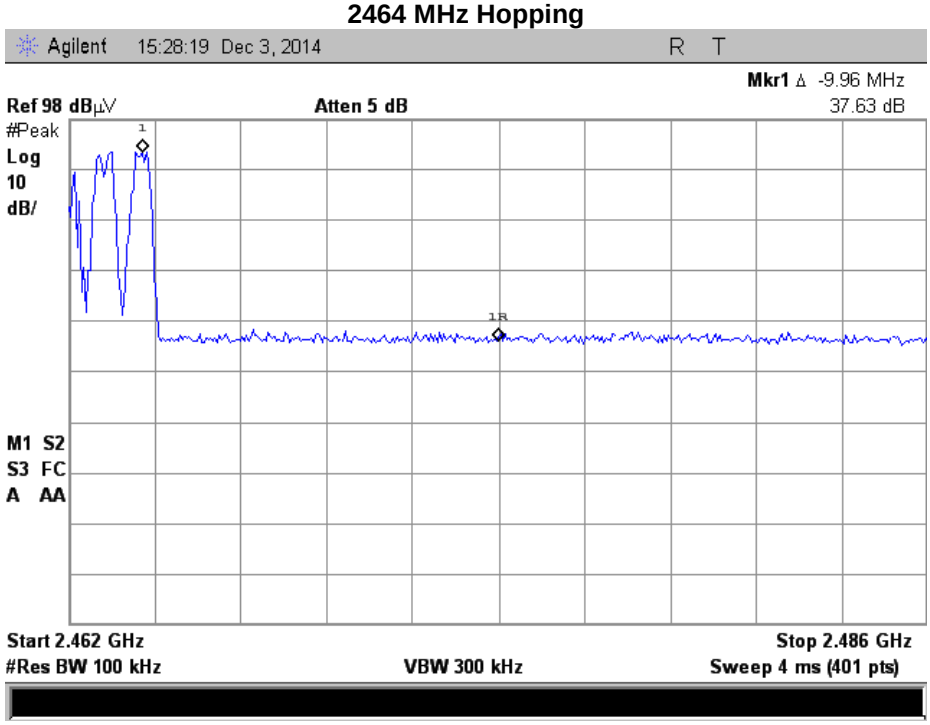


Band Edge 2483.5 MHz

2464 MHz CW



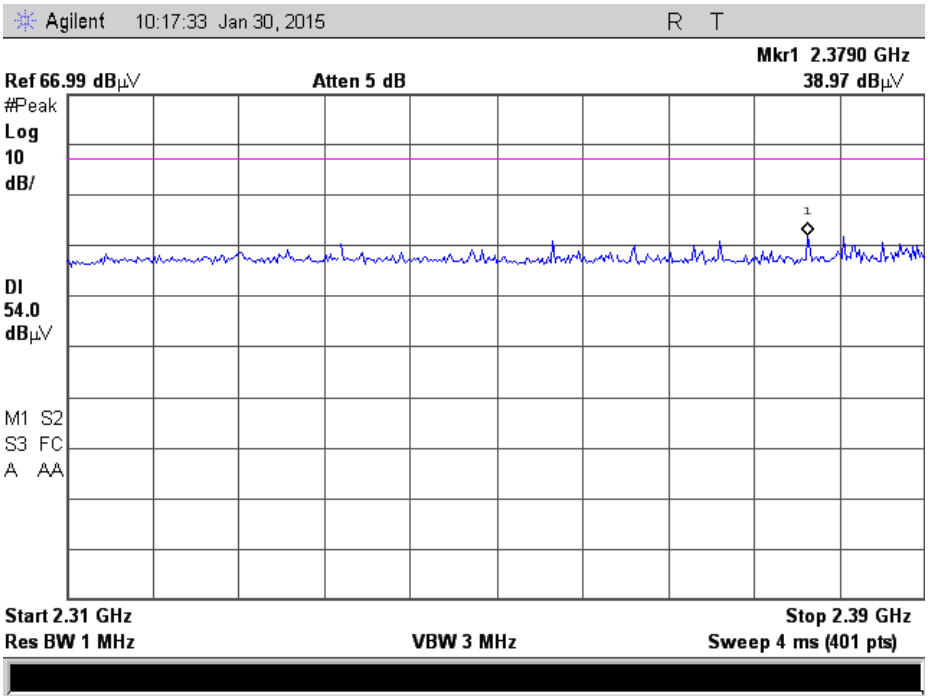
2464 MHz Hopping



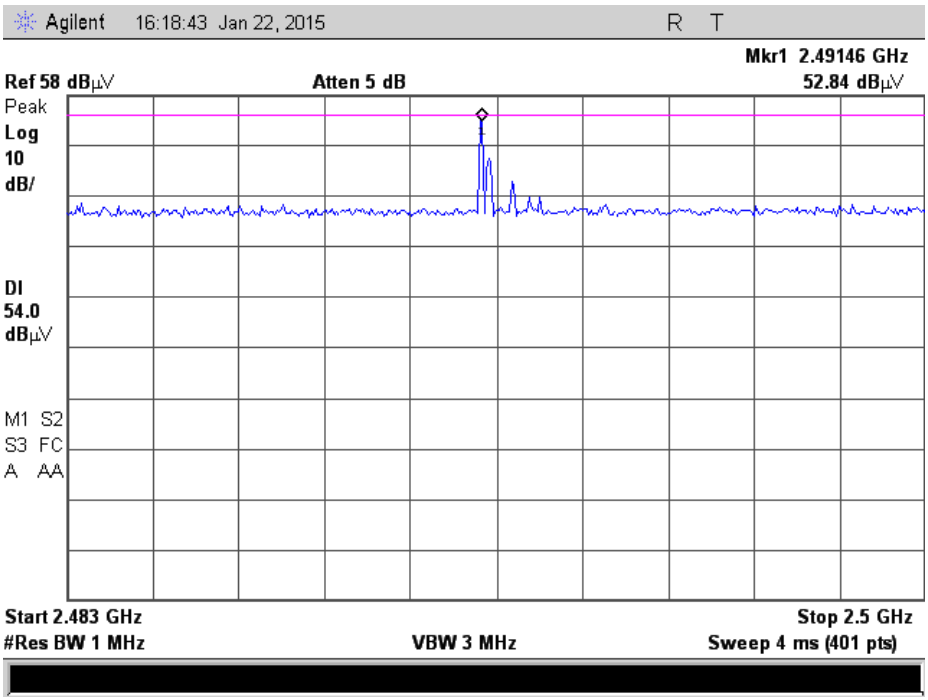
Restricted Band Emissions Summary

Tuned Frequency (MHz)	Emission Frequency (MHz)	Peak Monitored Level (dBuV/m)	Peak Limit (dBuV/m)	Average Monitored Level (dBuV/m)	Average Limit (dBuV/m)	Result
2401	2379.0	38.97	74.0	N/A	54.0	Pass
2464	2491.4	52.84	74.0	N/A	54.0	Pass

Restricted Band 2390 MHz



Restricted Band 2483.5 MHz



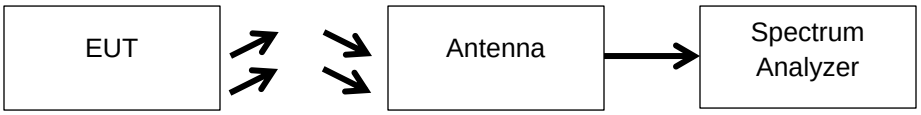
Occupied Bandwidth

Name of Test: Occupied Bandwidth **Engineer:** Alex Macon
Test Equipment Utilized: i00103, i00379, i00428 **Test Date:** 12/3/14

Test Procedure

The EUT was tested in a 3 meter semi-anechoic chamber. The Span was set wide enough to capture the entire transmitting spectrum and the resolution bandwidth was set to at least 1% of the span. The analyzer was set to max hold and when the entire spectrum was captured, the 20dB and 99% bandwidths were measured to verify that the bandwidth met the specification.

Test Setup



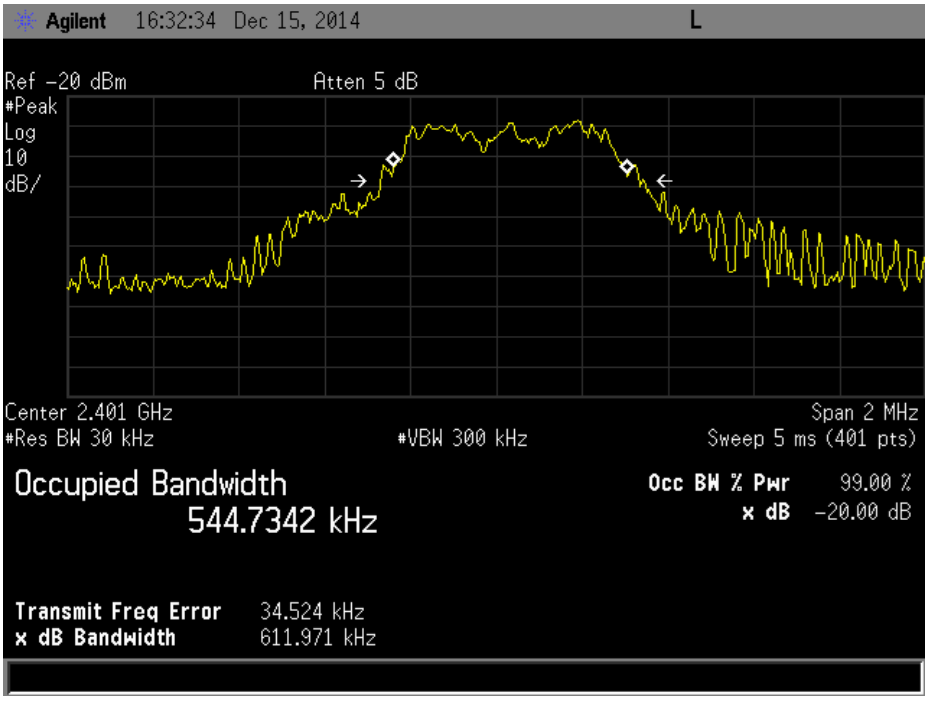
20 dB Bandwidth Summary

Frequency (MHz)	Recorded Measurement (kHz)
2401	612
2431	640
2464	623

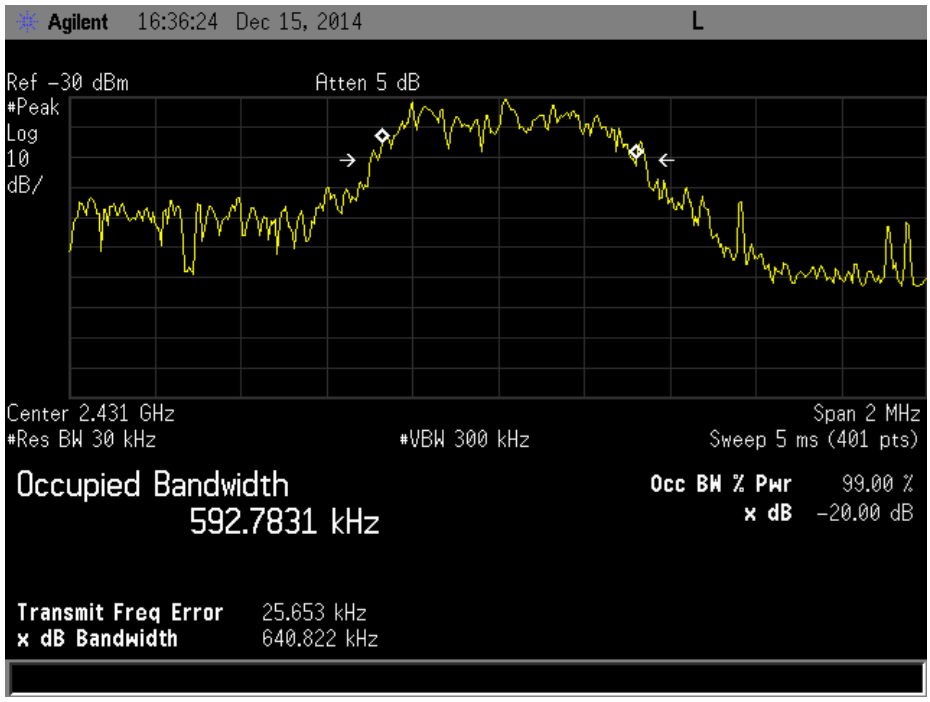
99% Bandwidth Summary

Frequency (MHz)	Recorded Measurement (kHz)
2401	544
2431	592
2464	545

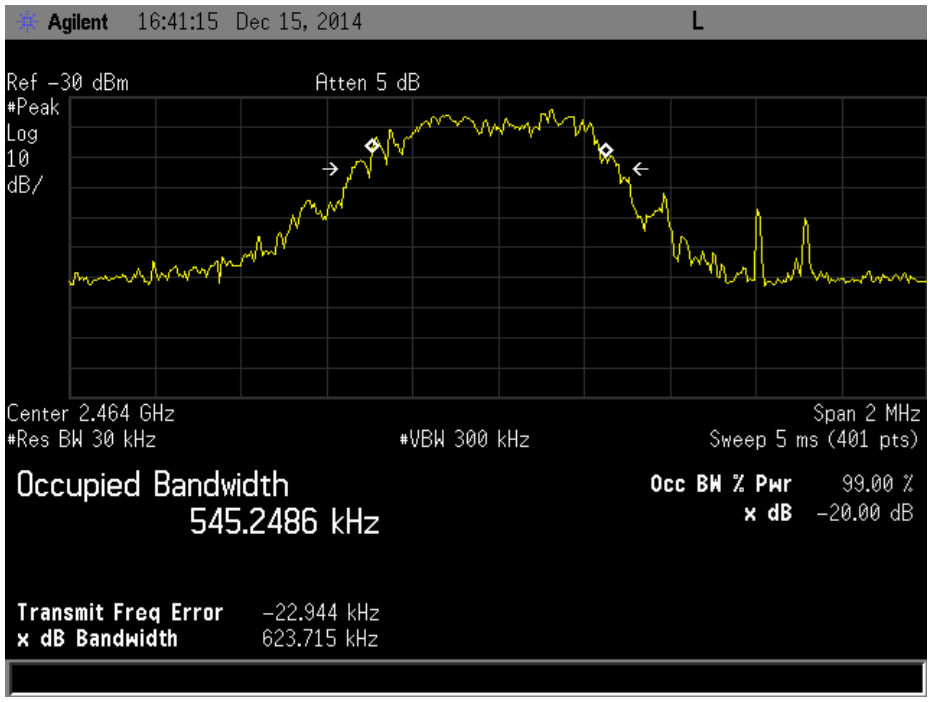
2402 MHz BW Plot



2431MHz BW Plot



2402MHz BW Plot



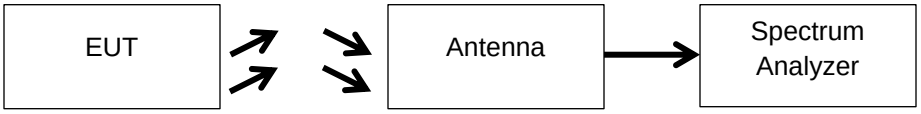
Dwell Time

Name of Test:	Dwell Time	**Engineer:** Alex Macon
Test Equipment Utilized:	i00103, i00379, i00428	**Test Date:** 12/4/14

Test Procedure

The EUT was tested in a 3 meter semi-anechoic chamber. The EUT was set to hopping mode with the spectrum analyzer set to a 0 Hz span. A single transmission was captured and the dwell time was recorded.

Test Setup



The Average Dwell time in a 25.2 second span (.4 * 63 channels) is 7ms.

Due to the infrequent duty of the transmitter in normal operation, it was deemed impractical to measure the dwell time using a spectrum analyzer. The manufacturer has provided a detailed timing document to determine compliance.

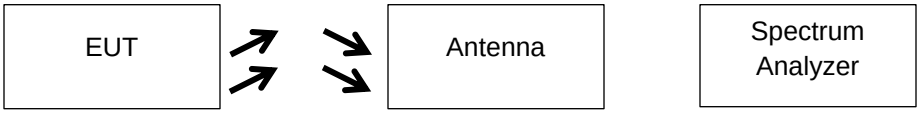
Number of Hopping Channels

Name of Test: Number of Hopping Channels **Engineer:** Alex Macon
Test Equipment Utilized: i00103, i00379, i00428 **Test Date:** 12/4/14

Test Procedure

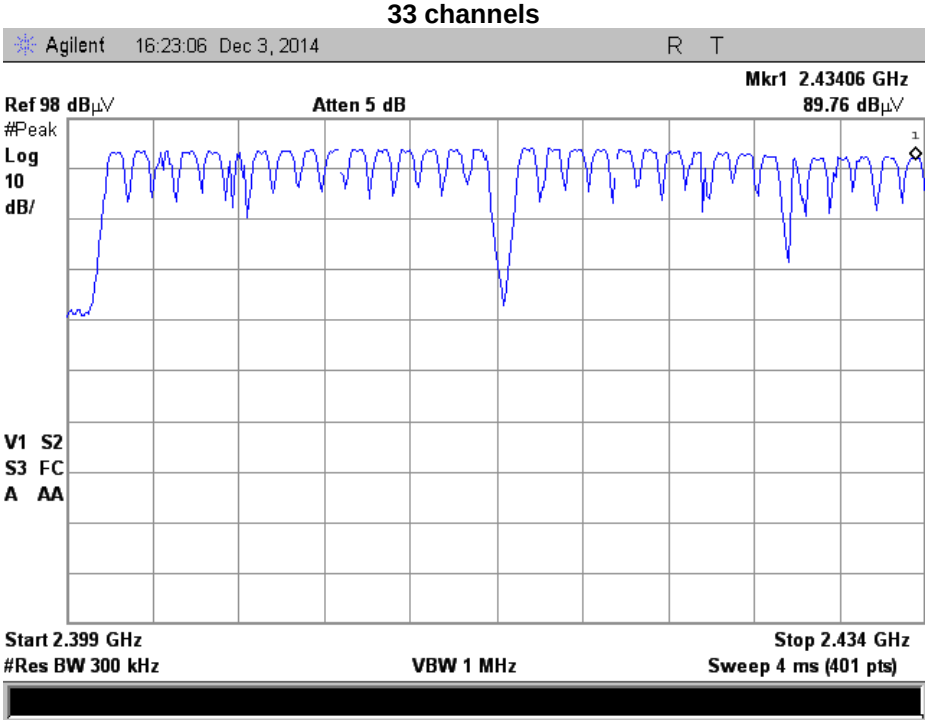
The EUT was tested in a 3 meter semi-anechoic chamber. The Span was set to the specified band end points. The EUT was then set to operate in hopping mode. The MAX HOLD function of the spectrum analyzer was utilized to verify the number of hopping cannels.

Test Setup

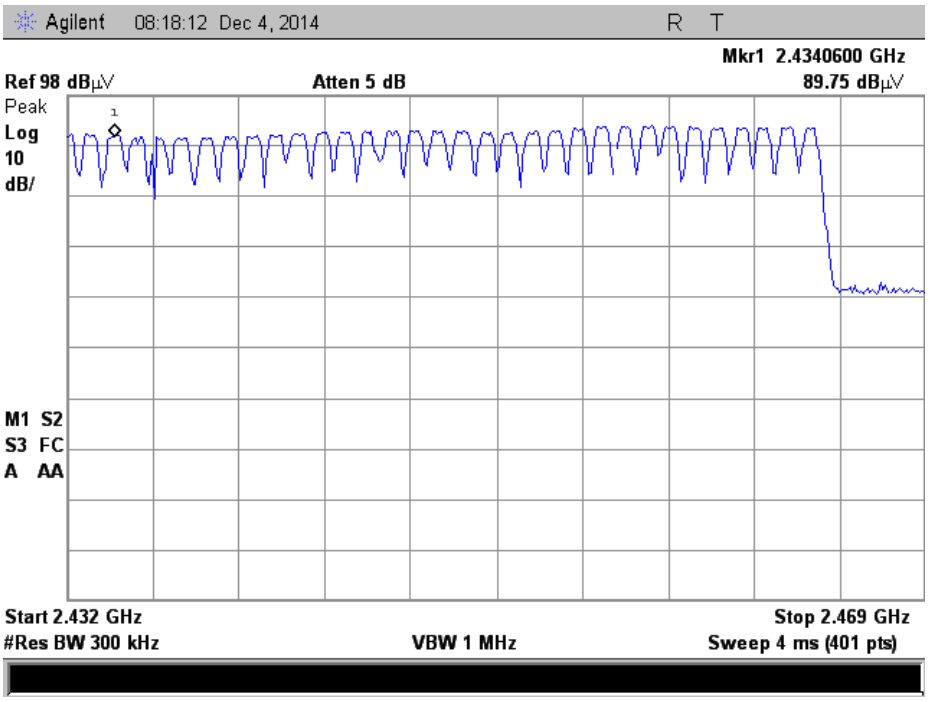


Number of Hopping Channels

33 channels



30 channels

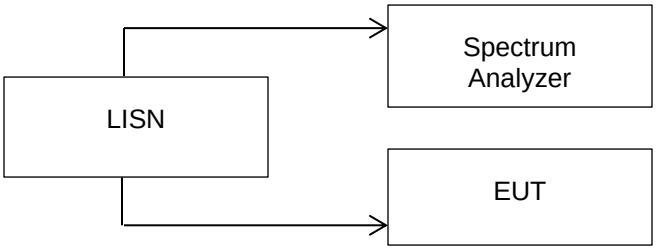


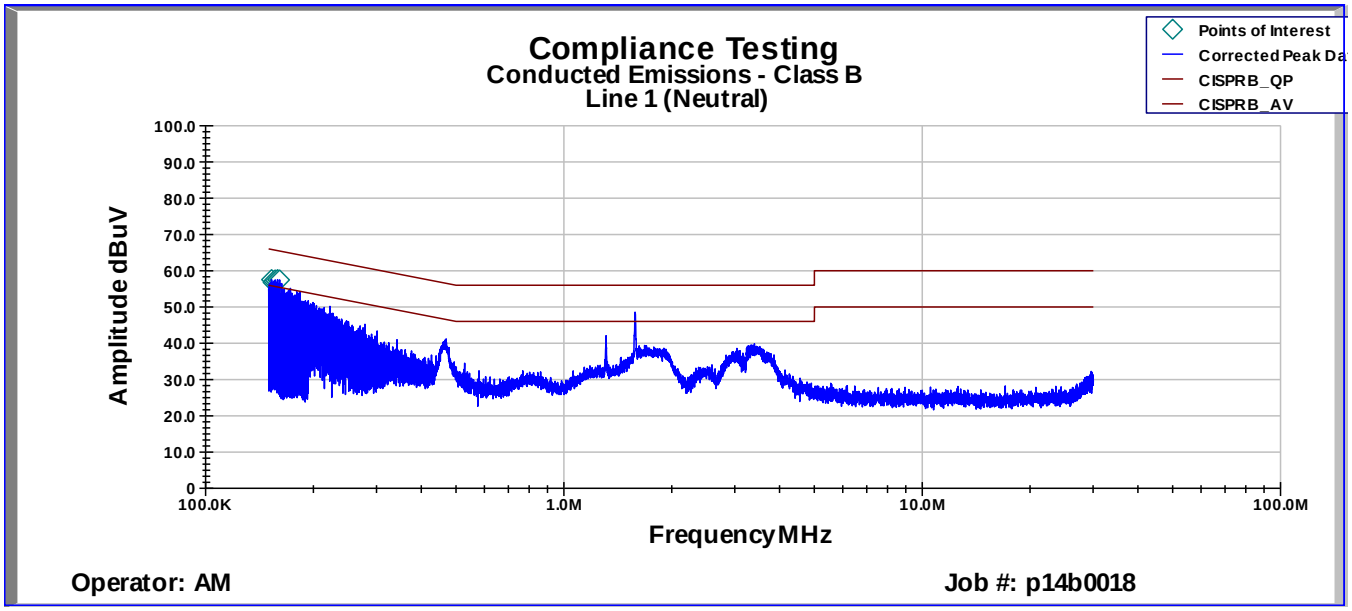
A total of 63 channels were plotted.

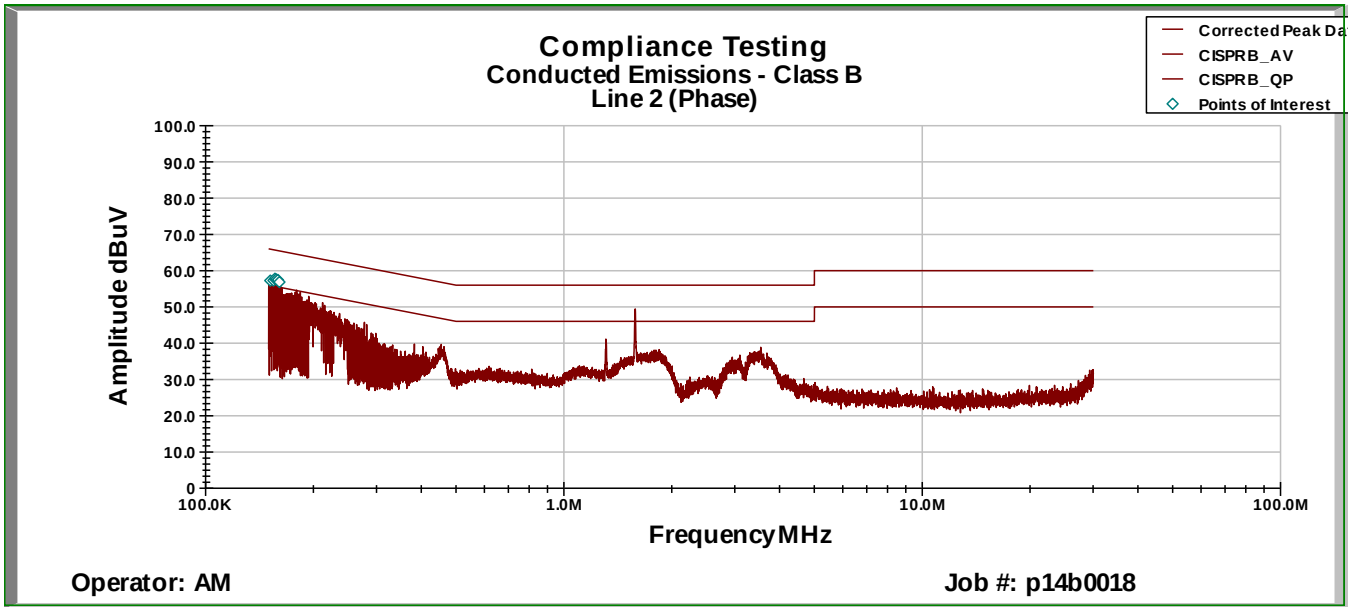
A/C Powerline Conducted Emissions

Name of Test:	A/C Powerline Conducted Emissions	**Engineer:**	Alex Macon
Test Equipment Utilized:	i00033, i00123, i00362, i00446, i00447	**Test Date:**	12/5/14

Test Setup







*The 1.31 MHz and 1.58 MHz emissions are ambient signals and are not created by the EUT

Line 1 Neutral Avg Detector

Frequency	Measured Value (dBuV)	LISN Correction Factor (dB)	Cable Loss (dB)	Transient Limiter (dB)	Final Data (dBuV)	Limit (dBuV)	Avg Margin (dB)
157.26 KHz	25.65	0.23	0.02	10.2	36.097	55.793	-19.695
155.65 KHz	26.63	0.24	0.02	10.2	37.09	55.839	-18.748
155.38 KHz	25.79	0.25	0.02	10.2	36.253	55.846	-19.593
153.41 KHz	25.73	0.27	0.02	10.2	36.216	55.903	-19.687
152.74 KHz	24.89	0.27	0.02	10.2	35.379	55.922	-20.542
151.73 KHz	24.71	0.28	0.02	10.2	35.216	55.951	-20.735

Line 2 Phase Avg Detector

Frequency	Measured Value (dBuV)	LISN Correction Factor (dB)	Cable Loss (dB)	Transient Limiter (dB)	Final Data (dBuV)	Limit (dBuV)	Avg Margin (dB)
157.73 KHz	25.97	0.22	0.02	10.2	36.413	55.779	-19.366
157.26 KHz	26.73	0.23	0.02	10.2	37.177	55.793	-18.615
156.6 KHz	25.91	0.23	0.02	10.2	36.361	55.811	-19.451
155.49 KHz	26.52	0.25	0.02	10.2	36.988	55.843	-18.855
152.56 KHz	25.3	0.27	0.02	10.2	35.791	55.927	-20.136
150.41 KHz	24.19	0.3	0.02	10.2	34.709	55.988	-21.279

Line 1 Neutral QP Detector

Frequency	Measured Value (dBuV)	LISN Correction Factor (dB)	Cable Loss (dB)	Transient Limiter (dB)	Final Data (dBuV)	Limit (dBuV)	QP Margin (dB)
157.26 KHz	45.09	0.227	0.02	10.2	55.537	65.793	-10.255
155.65 KHz	45.24	0.244	0.02	10.2	55.704	65.839	-10.135
155.38 KHz	45.42	0.246	0.02	10.2	55.886	65.846	-9.96
153.41 KHz	45.03	0.266	0.02	10.2	55.516	65.903	-10.387
152.74 KHz	44.11	0.273	0.02	10.2	54.603	65.922	-11.319
151.73 KHz	44.38	0.283	0.02	10.2	54.883	65.951	-11.068

Line 2 Phase QP Detector

Frequency	Measured Value (dBuV)	LISN Correction Factor (dB)	Cable Loss (dB)	Transient Limiter (dB)	Final Data (dBuV)	Limit (dBuV)	QP Margin (dB)
157.73 KHz	45.61	0.22	0.02	10.2	56.053	65.779	-9.726
157.26 KHz	44.87	0.23	0.02	10.2	55.317	65.793	-10.475
156.6 KHz	45.2	0.23	0.02	10.2	55.654	65.811	-10.157
155.49 KHz	44.86	0.25	0.02	10.2	55.325	65.843	-10.518
152.56 KHz	43.85	0.27	0.02	10.2	54.344	65.927	-11.582
150.41 KHz	43.34	0.3	0.02	10.2	53.856	65.988	-12.132

Test Equipment Utilized

Description	Manufacturer	Model #	CT Asset #	Last Cal Date	Cal Due Date
EMI Receiver	HP	8546A	i00033	2/24/14	2/24/15
Horn Antenna	EMCO	3115	i00103	12/11/12	12/11/14
High Pass Filter	Trilithic	4HX3400-3-XX	i00177	Verified on: 12/5/14	
Horn Antenna, Amplified	ARA	DRG-118/A	i00271	5/8/14	5/8/16
Horn Antenna, Amplified	ARA	MWH-1826/B	i00273	4/9/12	4/9/15
Humidity / Temp Meter	Newport	IBTHX-W-5	i00282	3/24/14	3/24/15
Voltmeter	Fluke	87III	i00319	2/22/14	2/22/15
Bi-Log Antenna	Schaffner	CBL 6111D	i00349	10/8/13	10/8/15
AC Power Source	Behlman	BL 6000	i00362	Verified on: 12/5/14	
EMI Analyzer	Agilent	E7405A	i00379	1/14/14	1/14/15
Thermo Hygrometer	Omega	RH81	i00408	4/15/13	4/15/15
3 Meter Semi-Anechoic Chamber	Panashield	3 Meter Semi-Anechoic Chamber	i00428	11/26/13	11/26/15
LISN	COM-Power	LI-125	i00446	7/25/14	7/25/15
LISN	COM-Power	LI-125A	i00447	7/25/14	7/25/15

In addition to the above listed equipment standard RF connectors and cables were utilized in the testing of the described equipment. Prior to testing these components were tested to verify proper operation.

END OF TEST REPORT