LS RESEARCH, LLC
Wireless Product Development

W66 N220 Commerce Court ● Cedarburg, WI 53012 USA ● Phone: 262.375.4400 ● Fax: 262.375.4248 ● www.lsr.com

ENGINEERING TEST REPORT # TR 315103 A
LSR Job #: C-2210

Compliance Testing of:
OneExpert CATV

Test Date(s):
April-June 2015

Prepared For:
JDSU
5808 Churchman Bypass
Indianapolis, IN 46203

This Test Report is issued under the Authority of: Tom Smith, VP EMC Test Services

Signature: Date: 9-1-15

Test Report Reviewed by:	**Report by:**
Tom Smith, VP EMC Test Services	Adam Alger, EMC Engineer
Signature: Date: 8-7-15	Signature: Date: 8-3-15

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LS Research, LLC in Review

As an EMC Testing Laboratory, our Accreditation and Assessments are recognized through the following:

TESTING CERT #1255.01

A2LA – American Association for Laboratory Accreditation

Accreditation based on ISO/IEC 17025: 2005 with Electrical (EMC) Scope of Accreditation
A2LA Certificate Number: 1255.01

Federal Communications Commission (FCC) – USA

Listing of 3 Meter Semi-Anechoic Chamber based on Title 47 CFR – Part 2.948
FCC Registration Number: 90756

Industrie Canada Industry Canada

Canada

Industry Canada

On file, 3 Meter Semi-Anechoic Chamber based on RSS-212 – Issue 1
File Number: IC 3088-A
On file, 3 and 10 Meter OATS based on RSS-212 – Issue 1
File Number: IC 3088

U. S. Conformity Assessment Body (CAB) Validation

Validated by the European Commission as a U. S. Competent Body operating under the U. S./EU, Mutual Recognition Agreement (MRA) operating under the European Union Electromagnetic Compatibility –Council Directive 2004/108/EC (formerly 89/336/EEC, Article 10.2).
Date of Validation: January 16, 2001

Validated by the European Commission as a U.S. Notified Body operating under the U.S. /EU, Mutual Recognition Agreement (MRA) operating under the European Union Telecommunication Equipment – Council Directive 99/5/EC, Annex V.
Date of Validation: November 20, 2002
Notified Body Identification Number: 1243

1.0 Summary of Test Report

In April-June 2015 the EUT, OneExpert CATV, as supplied by JDSU was tested and MEETS the following requirements:

FCC Requirement	IC Requirement	Test Requirements	Measurement Procedure	Compliance (Yes/No)
15.247 (a)(2)	RSS-247 Section 5.2 (1)	6 dB Bandwidth of a Digital Modulation System	ANSI C63.10-2013 Section 11.8	Yes
15.247(b) & 1.1310	RSS-247 Section 5.4 (4)	Maximum Output Power	ANSI C63.10-2013 Section 11.9	Yes
15.247 (e)	RSS-247 Section 5.2 (2)	Power Spectral Density of a Digital Modulation System	ANSI C63.10-2013 Section 11.10	Yes
15.247(d)	RSS-247 Section 5.5	RF Conducted Spurious Emissions at the Transmitter Antenna Terminal	ANSI C63.10-2013 Section 11.11	Yes
15.247(c), 15.209 & 15.205	RSS-GEN Section 8.9, 8.10	Transmitter Radiated Emissions in Restricted Bands	ANSI C63.10-2013 Section 11.12 (6.3,6.5,6.6)	Yes
2.1055 (d)	RSS-GEN Section 6.11	Frequency Stability	ANSI C63.10-2013 Section 6.8	Yes
15.207	RSS-GEN Section 8.8	Power Line Conducted Emissions Measurements	ANSI C63.10-2013 Section 6.2	Yes

2.0 Test Facilities

All testing was performed at:

LS Research, LLC
W66 N220 Commerce Court
Cedarburg, Wisconsin, 53012 USA

LS Research, LLC is accredited by A2LA (American Association for Laboratory Accreditation) to the requirements of ISO/IEC 17025, 2005 “General Requirements for the Competence of Calibration and Testing Laboratories”.
LS Research, LLC’s scope of accreditation includes all test methods listed herein, unless otherwise noted.

3.0 Client Information

Manufacturer Name:	JDSU
Address:	5808 Churchman Bypass Indianapolis, IN 46203
Contact Person:	Adam Nowotarski

3.1 Equipment Under Test (EUT) Information

The following information has been supplied by the applicant.

Product Name:	OneExpert CATV
Model Number:	OneExpert CATV
Serial Number:	Eng. Sample
FCC ID:	WUW-22100382
IC:	9613A-22100382

3.2 Product Description

Bluetooth device using Bluetooth Low Energy
802.11 b/g/n device using HT20 channels 1-11
Device does not transmit BT and WLAN simultaneously

3.3 Modifications Incorporated In the EUT for Compliance Purposes

None noted at time of test

3.4 Deviations & Exclusions from Test Specifications

None noted at time of test

3.5 Additional Information

Low Channel 0 (2402MHz), Middle Channel 39 (2441 MHz), High Channel 78 (2480 MHz). EUT programmed for continuous transmit or receive on selectable channel and data rate (modulation) using hyper terminal program connection via Ethernet port on EUT for BLE.

Low Channel 1(2412 MHz), Middle Channel 6 (2437 MHz), High Channel 11 (2462 MHz). EUT programmed for continuous transmit or receive on selectable channel and data rate (modulation) using hyper terminal program connection via Ethernet port on EUT for WLAN.

4.0 Conditions of Test

Environmental:

Temperature: 20-25º C
Relative Humidity: 30-60%
Atmospheric Pressure: 86-106 kPa

Mains Voltage: 120 VAC 60 Hz

5.0 Test Equipment

All test equipment is calibrated by a calibration laboratory accredited by A2LA to the requirements of ISO 17025. For a complete list of test equipment and calibration dates, see Appendix A. Unless otherwise noted, resolution bandwidth of measuring instrument used during testing for given frequency range, see below.

Frequency Range	Resolution Bandwidth
9 kHz – 150 kHz	200 Hz
150 kHz – 30 MHz	9 kHz
30 MHz – 1000 MHz	120 kHz
Above 1000 MHz	1 MHz

6.0 Conformance Summary

The EUT was found to MEET the requirements as described within the specification of FCC Title 47, CFR Part 15.247, 15.207 as well as Industry Canada RSS-247 Issue 1, RSS-GEN Issue 4.

If some emissions are seen to be within 3 dB of their respective limits:
As these levels are within the tolerances of the test equipment and site employed, there is a possibility that this unit, or a similar unit selected out of production may not meet the required limit specification if tested by another agency.

LS Research, LLC certifies that the data contained herein was taken under conditions that meet or exceed the requirements of the test specifications. The results in this Test Report apply only to the item(s) tested on the above-specified dates. Any modifications made to the EUT subsequent to the indicated test date(s) will invalidate the data herein, and void this certification.

Appendix A – Test Equipment

LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date : 22-Apr-2015 Type Test : Emissions Job # : C-2210

Prepared By: Shane Rismeyer Customer : JDSU Quote #: 315103

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960073	Spectrum Analyzer	Agilent	E4446A	US45300564	10/19/2014	10/19/2015	Active Calibration
2	EE 960088	8GHz MXE Spectrum Analyzer	Agilent	N9038A	MY51210138	1/9/2015	1/9/2016	Active Calibration
3	AA 960078	Log Periodic Antenna	EMCO	93146	9701-4855	1/19/2015	1/19/2016	Active Calibration
4	AA 960150	Biconical Antenna	ETS	3110B	0003-3346	1/22/2015	1/22/2016	Active Calibration
5	EE 960146	Std. Gain Horn Ant. w/preamp	Adv. Micro / EMC	WLA622-4 / 3160-09	123001	8/20/2014	8/20/2015	Active Calibration
6	AA 960137	Standard Gain Horn Ant.	EMCO	3160-10	69259	8/20/2014	8/20/2015	Active Calibration
7	AA 960158	Double Ridge Horn Antenna	ETS Lindgren	3117	109300	6/20/2014	6/20/2015	Active Calibration
8	EE 960159	0.8 - 21GHz LNA	Mini-Circuits	ZVA-213X-S+	740411007	6/20/2014	6/20/2015	Active Calibration
9	AA 960161	Highpass Filter	K&L Microwave	11SH10-8000	2	2/6/2015	2/6/2016	Active Calibration
10	EE 960089	LISN - 15A	COM-POWER	LI-215A	191943	3/2/2015	3/2/2016	Active Calibration

Project Engineer: Shane Rismeyer Quality Assurance: Peter Finken

Appendix B – Test Data
B.1 – RF Conducted Emissions

Manufacturer	JDSU
Test Location	LS Research, LLC
Rule Part	FCC 15.247 IC RSS-247
General Measurement Procedure	ANSI C63.10 Section 6.7
General Description of Measurement	A direct measurement of the transmitted signal was performed at the antenna port of the EUT via a cable connection to a spectrum analyzer. An attenuator was placed in series with the cable to protect the spectrum analyzer. The loss from the cable and the attenuator were added on the analyzer as gain offset settings there by allowing direct measurements, without the need for any further corrections. The EUT was configured to run in a continuous transmit mode, while being supplied with typical data as a modulation source.

B.1.1 – RF Conducted – Fundamental Bandwidth

Manufacturer	JDSU
Date	4-22, 5-12 2015
Operator	Shane R.
Temp. / R.H.	20 - 25º C / 30-60% R.H.
Rule Part	FCC 15.247 (a)(2) IC RSS-247 Section 5.2(1)
Specific Measurement Procedure	ANSI C63.10-2013 Section 11.8
Additional Description of Measurement	Peak detector used
Additional Notes	Continuous transmit modulated used for this test.

Table

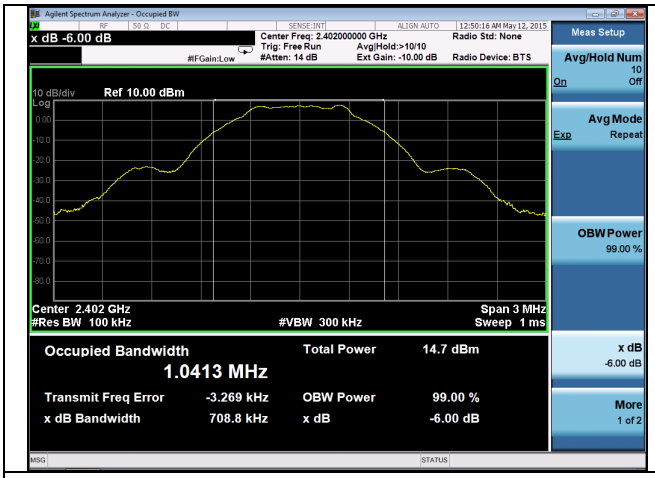
Mode	Frequency (MHz)	99 % BW (MHz)	6 dB DTS BW (MHz)	20 dB OBW (MHz)
BLE	2402	1.039	0.709	1.183
	2441	1.035	0.706	1.179
	2480	1.035	0.711	1.180

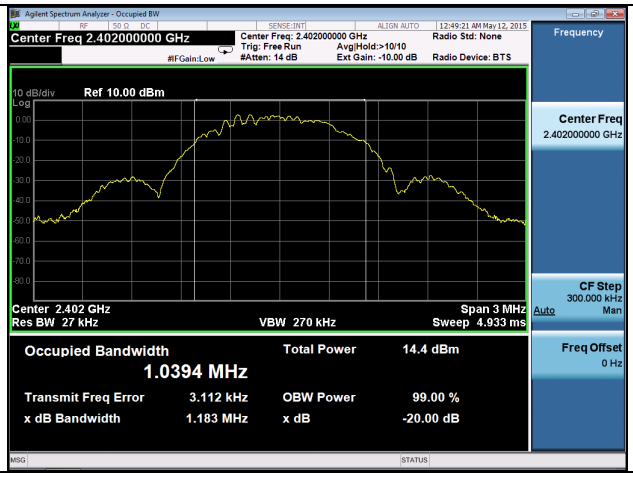
WLAN

Mode (802.11)	Mode (Mbps)	Frequency (MHz)	99 % BW (MHz)	6 dB DTS BW (MHz)	20 dB OBW (MHz)
b	1	2412	13.90	9.10	16.15
		2437	13.98	9.10	16.17
		2462	13.99	9.10	16.18
g	6	2412	16.58	16.35	19.83
		2437	16.61	16.32	20.00
		2462	16.65	16.29	19.99
n	6.5	2412	17.74	15.15	20.00
		2437	17.77	15.15	20.00
		2462	17.82	15.44	20.00

Plots – BLE

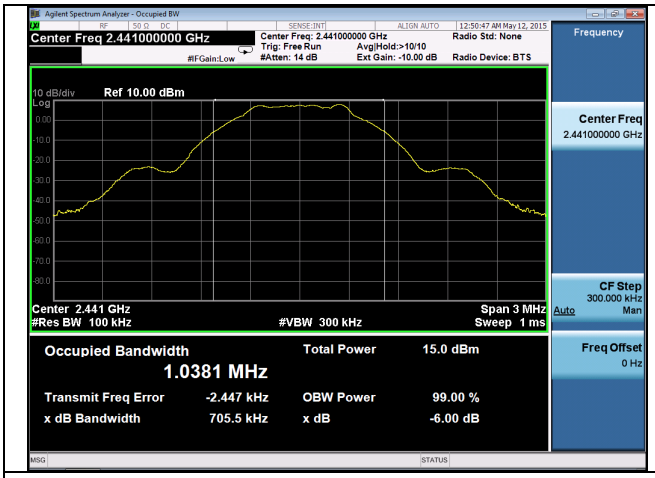
Low Channel – 2402 MHz

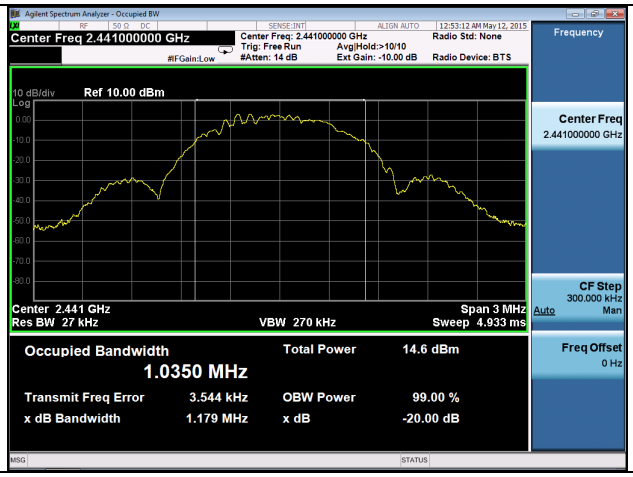




6 dB DTS BW	20 dB OBW + 99% BW

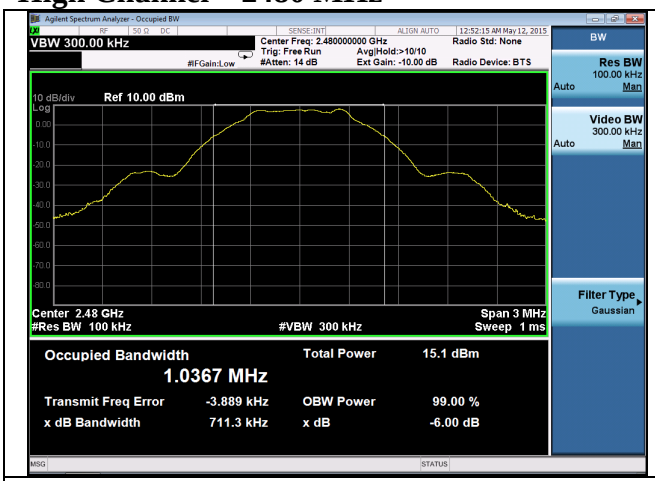
Mid Channel – 2441 MHz

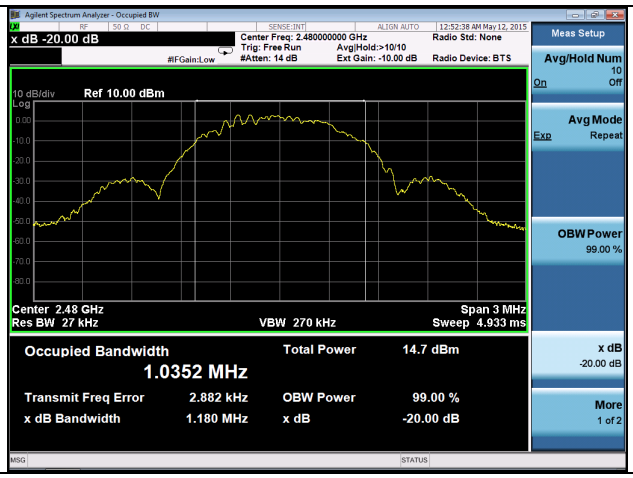




6 dB DTS BW	20 dB OBW + 99% BW

High Channel – 2480 MHz

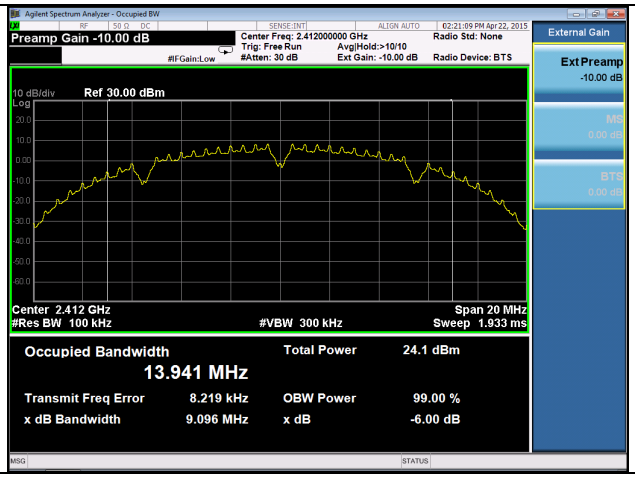




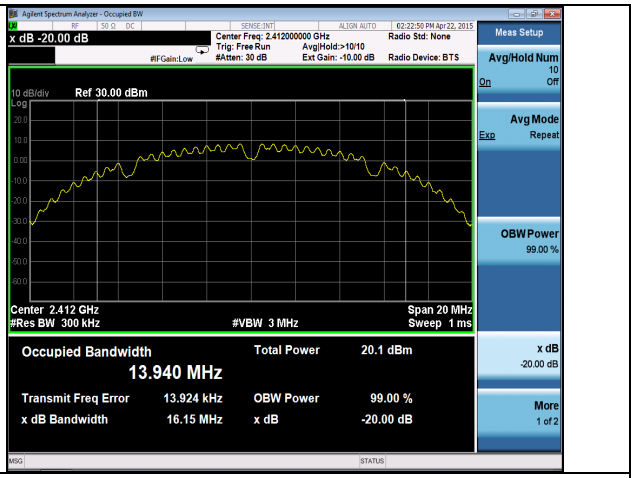
6 dB DTS BW	20 dB OBW + 99% BW

Plots 802.11b – 1 Mbps

Low Channel – 2412 MHz

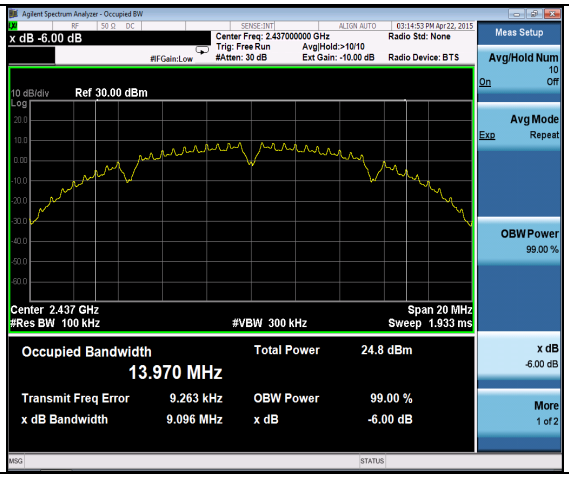


6 dB DTS BW

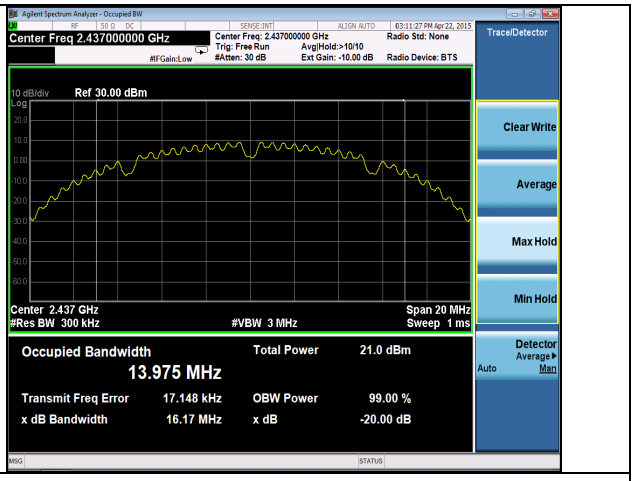


20 dB OBW + 99% BW

Mid Channel – 2437 MHz

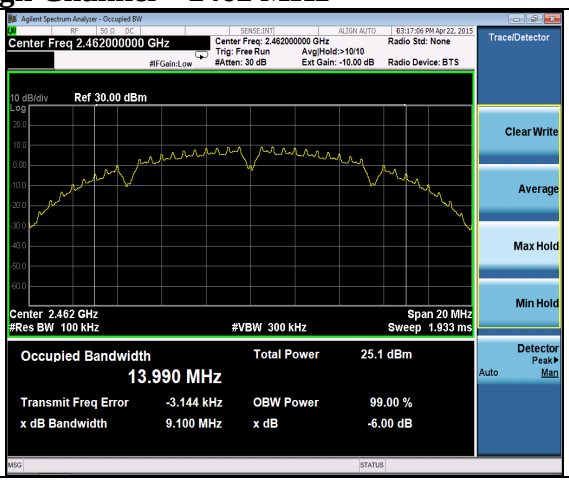


6 dB DTS BW

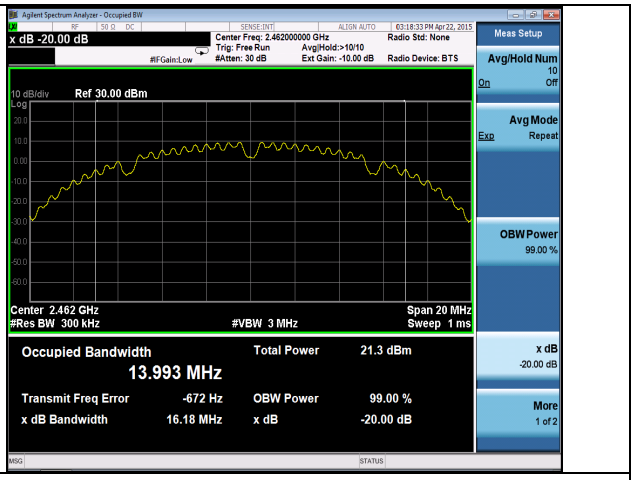


20 dB OBW + 99% BW

High Channel – 2462 MHz



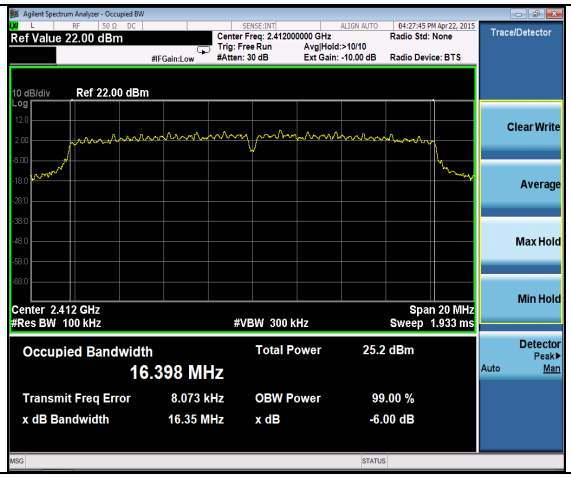
6 dB DTS BW



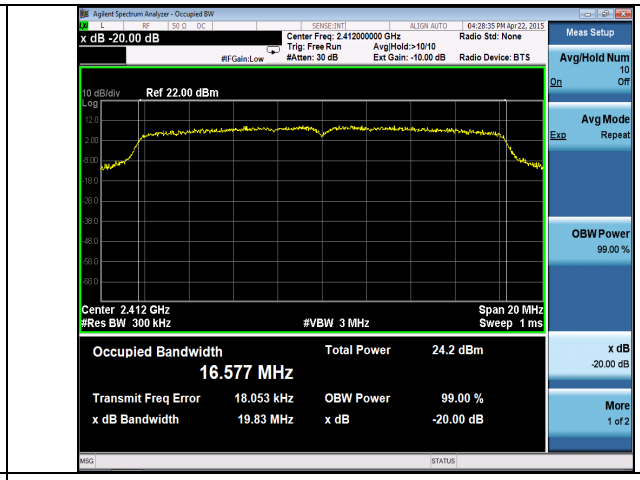
20 dB OBW + 99% BW

802.11b – 6 Mbps

Low Channel – 2412 MHz

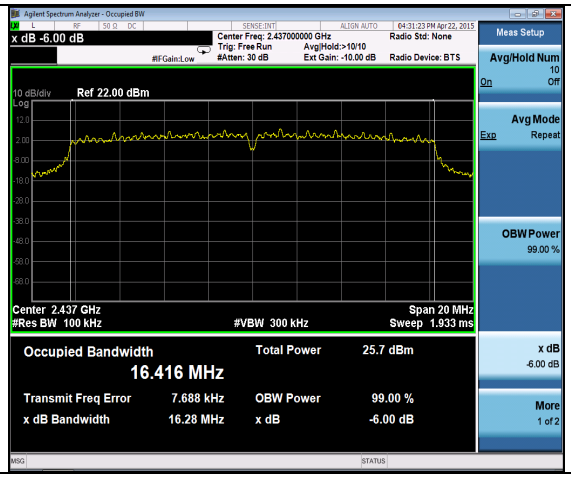


6 dB DTS BW

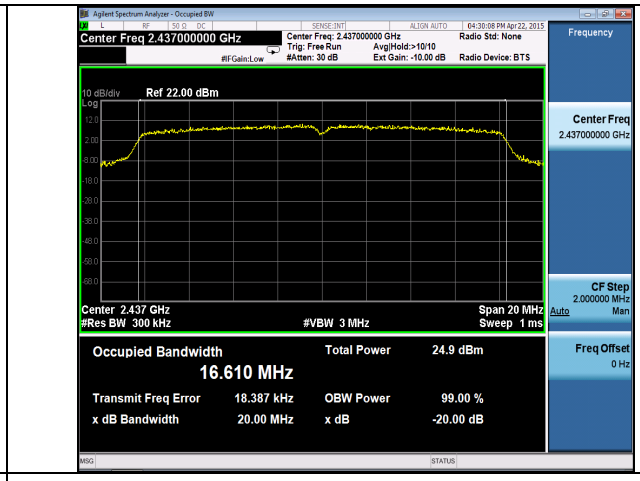


20 dB OBW + 99% BW

Mid Channel – 2437 MHz

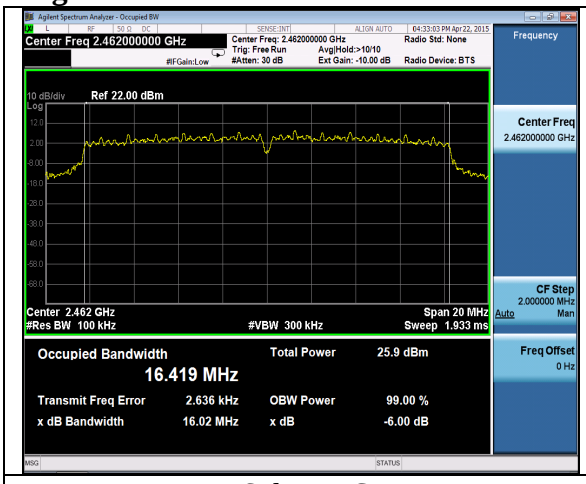


6 dB DTS BW

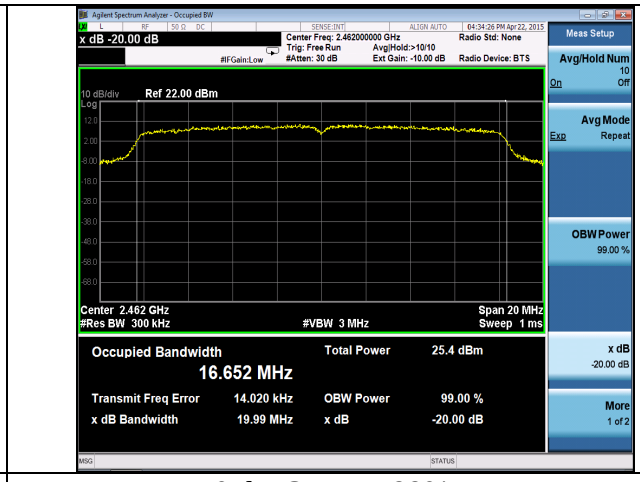


20 dB OBW + 99% BW

High Channel – 2462 MHz



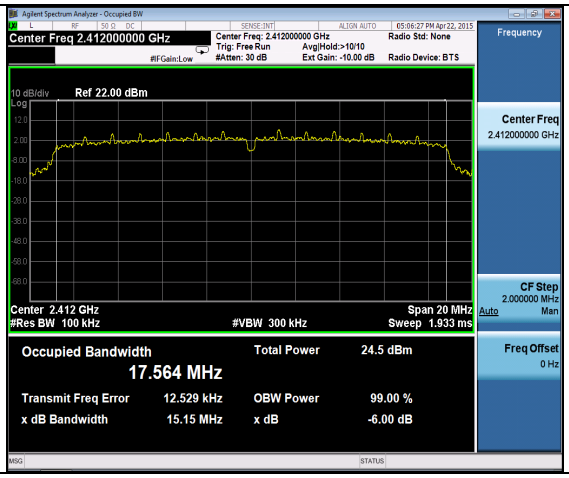
6 dB DTS BW



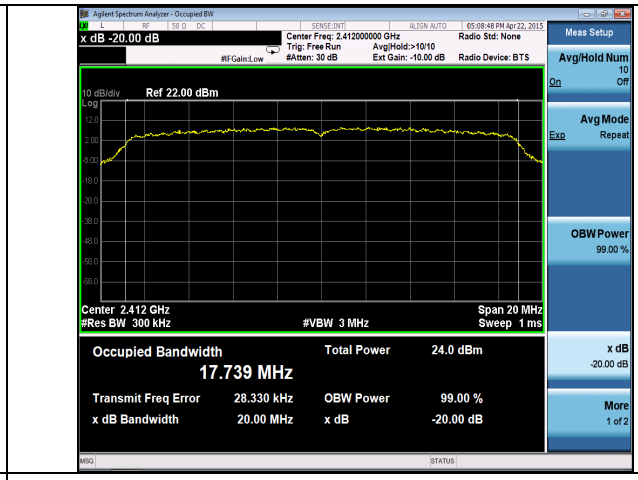
20 dB OBW + 99% BW

802.11n – 6.5 Mbps

Low Channel – 2412 MHz

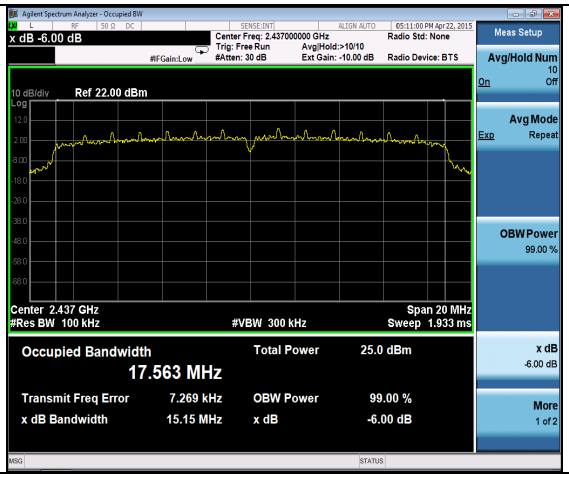


6 dB DTS BW

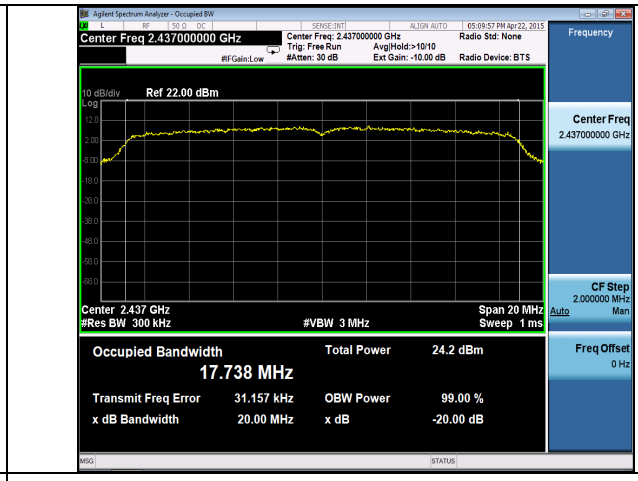


20 dB OBW + 99% BW

Mid Channel – 2437 MHz



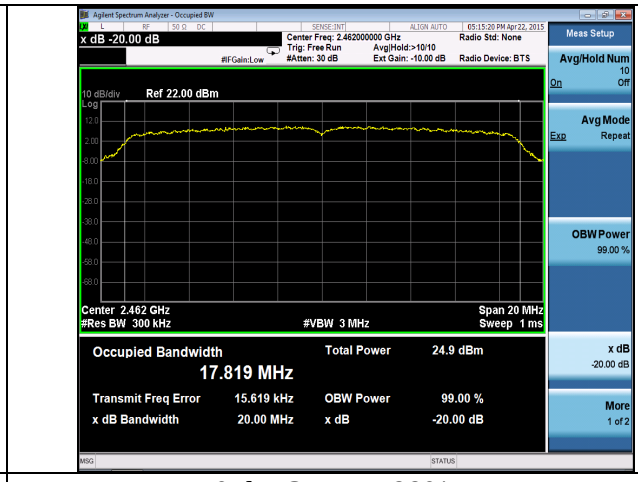
6 dB DTS BW



20 dB OBW + 99% BW

High Channel – 2462 MHz

6 dB DTS BW



20 dB OBW + 99% BW

B.1.2 – RF Conducted – Fundamental Power and Spectral Density

Manufacturer	JDSU
Date	5-7, 12, 28 2015
Operator	Shane R.
Temp. / R.H.	20 - 25º C / 30-60% R.H.
Rule Part	FCC 15.247 (b) & (e) IC RSS-247 Section 5.4 (4) & 5.2 (2)
Specific Measurement Procedure	ANSI C63.10-2013 Power - Section 11.9.1.1 (BLE) and 11.9.2.2.4 (WLAN) PSD – Section 11.10.2 (BLE) and 11.10.5
Additional Description of Measurement	30 kHz resolution bandwidth used for Power Spectral Density measurement Peak methods for BLE Average methods for WLAN
Additional Notes	Continuous transmit modulated used for this test. Sample Calculation: Margin (dB) = Limit – Measured level

Table

BLE

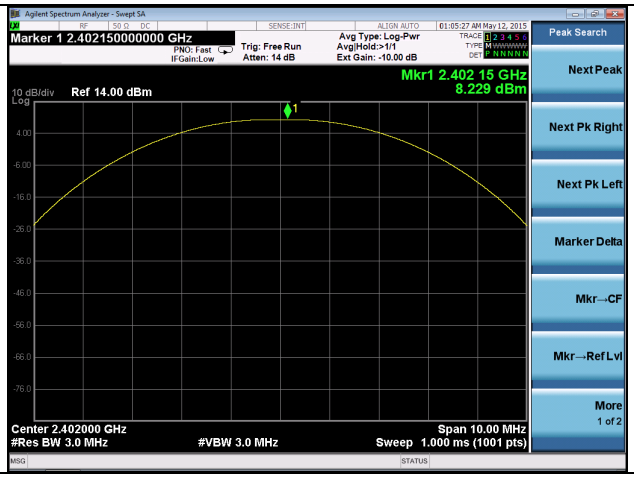
Frequency (MHz)	99 % BW (MHz)	6 dB DTS BW (MHz)	20 dB OBW (MHz)	Meas Power (dBm)	Power Limit (dBm)	Power Margin (dB)	Meas PSD 30 kHz (dBm)	PSD Limit (dBm / 3 kHz)	PSD Margin (dB)
2402	1.039	0.709	1.183	8.23	30	21.77	3.29	8	4.71
2441	1.035	0.706	1.179	8.58		21.42	3.49		4.51
2480	1.035	0.711	1.180	8.66		21.34	3.74		4.26

WLAN

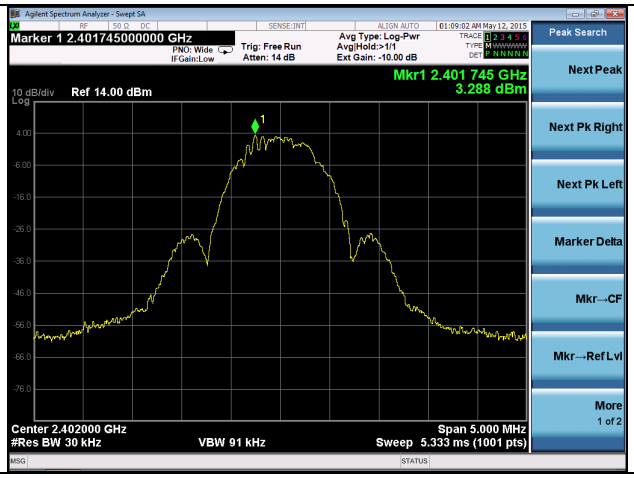
Mode (802.11)	Mode (Mbps)	Frequency (MHz)	99 % BW (MHz)	6 dB DTS BW (MHz)	20 dB OBW (MHz)	Meas Power (dBm)	Duty (dB)	Max Avg. Power (dBm)	Max Avg. Power Limit (dBm)	Max Avg. Power Margin (dB)	Meas PSD 30 kHz (dBm)	Duty (dB)	Max Avg. PSD 30 kHz (dBm)	Max Avg. PSD Limit (dBm / 3 kHz)	Max Avg. PSD Margin (dB)
b	1	2412	13.90	9.10	16.15	18.46	0.0	18.46	30	11.54	2.76	0.0	2.76	8	5.24
		2437	13.98	9.10	16.17	18.96	0.0	18.96		11.04	4.67	0.0	4.67		3.33
		2462	13.99	9.10	16.18	19.10	0.0	19.10		10.90	4.81	0.0	4.81		3.19
g	6	2412	16.58	16.35	19.83	17.30	0.0	17.30		12.70	1.81	0.0	1.81		6.19
		2437	16.61	16.32	20.00	17.60	0.0	17.60		12.40	0.92	0.0	0.92		7.08
		2462	16.65	16.29	19.99	17.74	0.0	17.74		12.26	2.29	0.0	2.29		5.71
n	6.5	2412	17.74	15.15	20.00	17.10	0.2	17.30		12.70	0.57	0.2	0.77		7.23
		2437	17.77	15.15	20.00	17.50	0.2	17.70		12.30	0.91	0.2	1.11		6.89
		2462	17.82	15.44	20.00	17.64	0.2	17.84		12.16	1.34	0.2	1.54		6.46

Plots – BLE

Low Channel – 2402 MHz

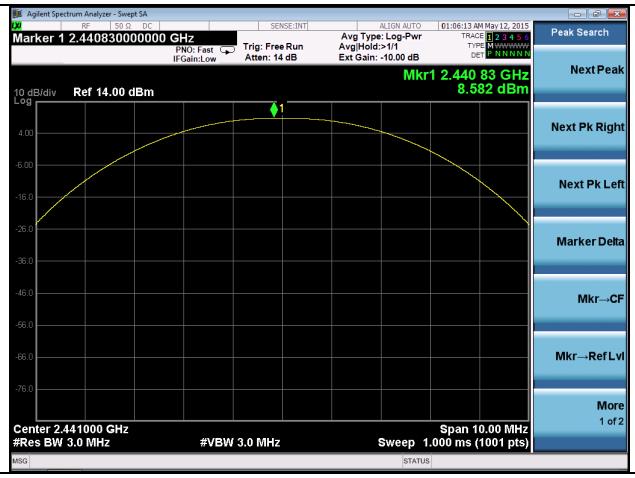


Output Power

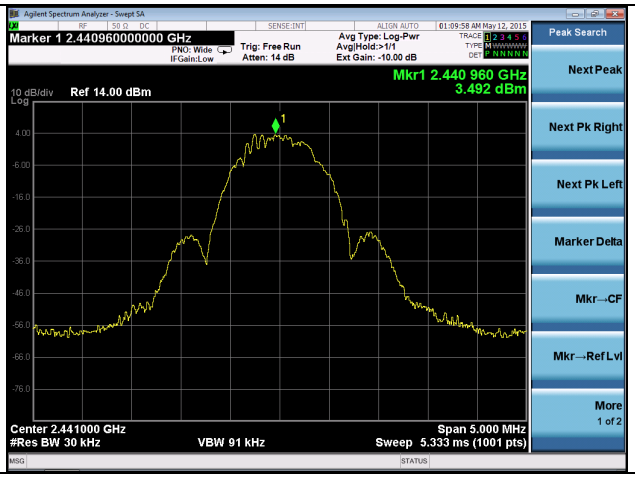


Power Spectral Density

Mid Channel – 2441 MHz

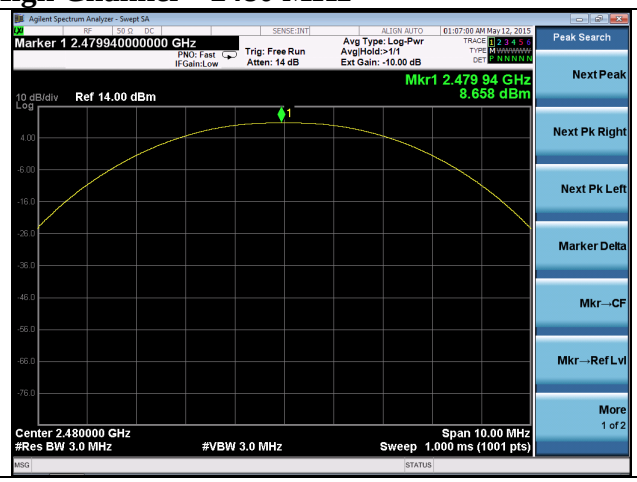


Output Power

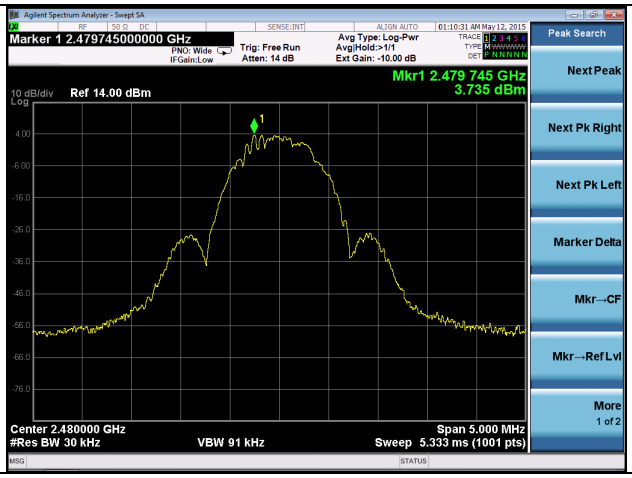


Power Spectral Density

High Channel – 2480 MHz



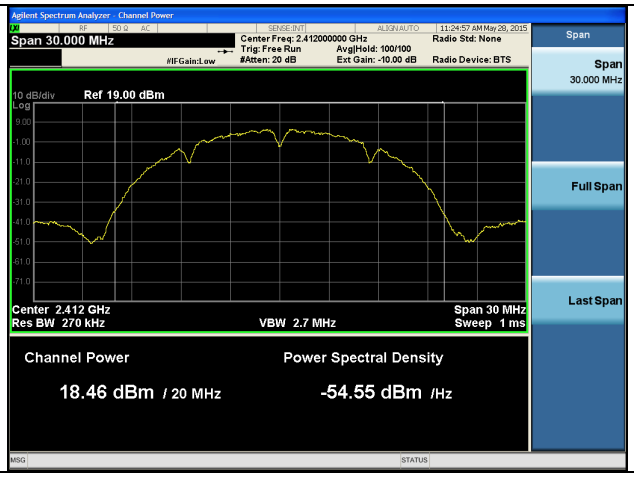
Output Power



Power Spectral Density

Plots - 802.11b – 1 Mbps

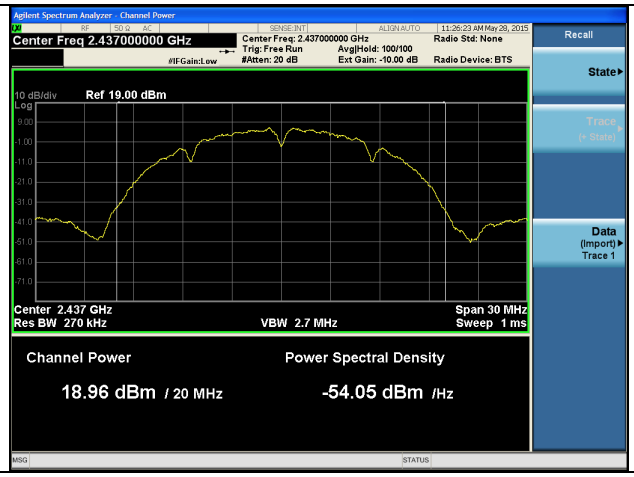
Low Channel – 2412 MHz



Output Power

Power Spectral Density

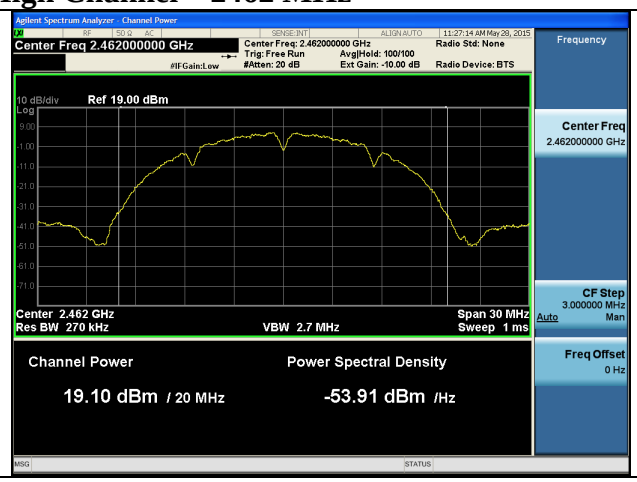
Mid Channel – 2437 MHz



Output Power

Power Spectral Density

High Channel – 2462 MHz

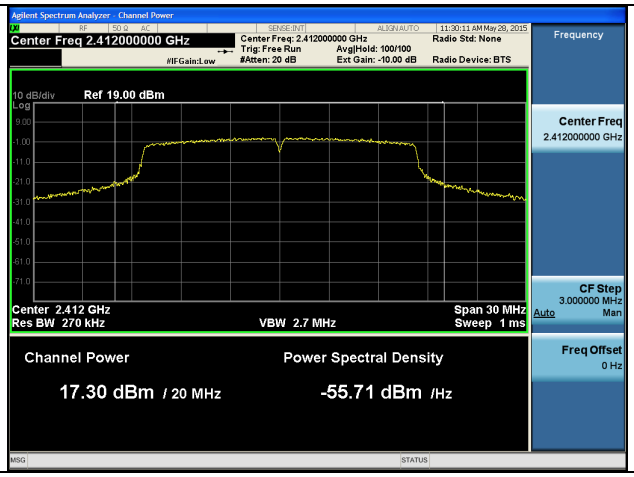


Output Power

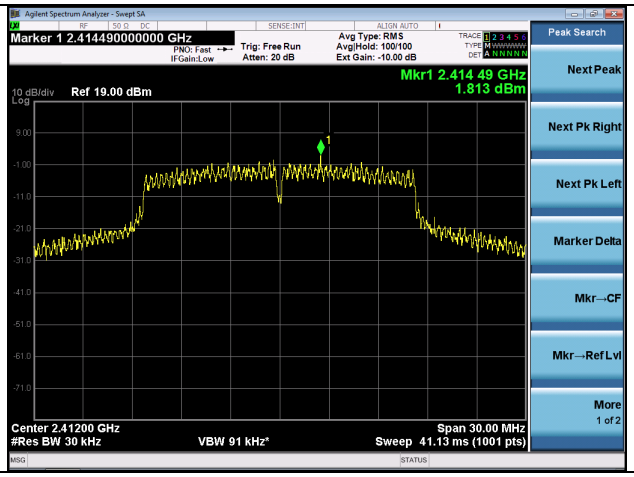
Power Spectral Density

802.11g – 6 Mbps

Low Channel – 2412 MHz

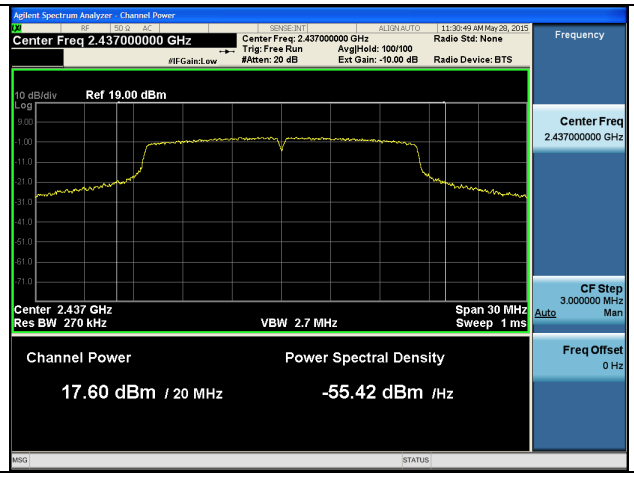


Output Power

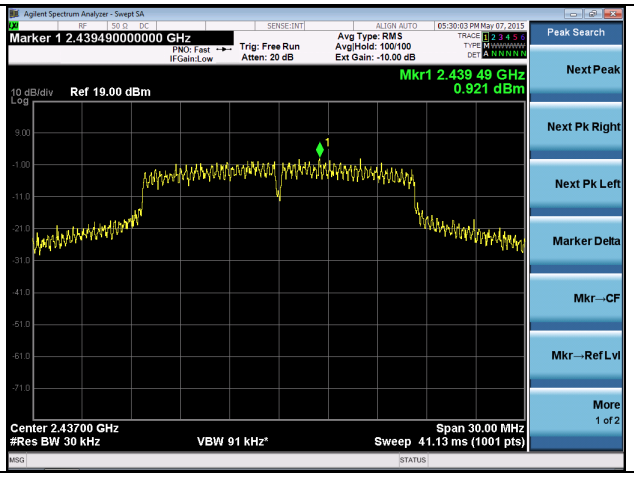


Power Spectral Density

Mid Channel – 2437 MHz

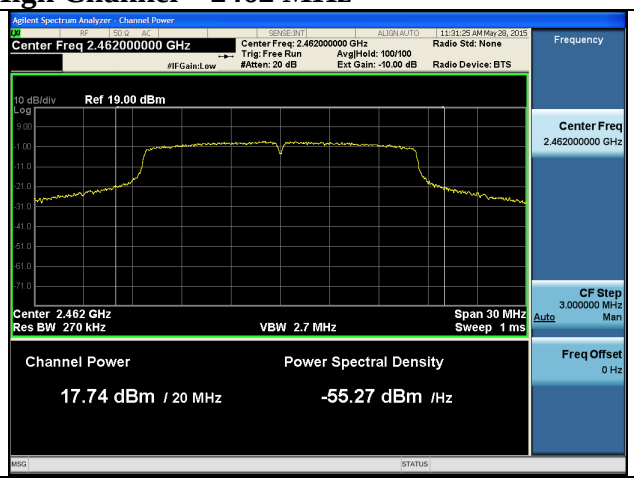


Output Power

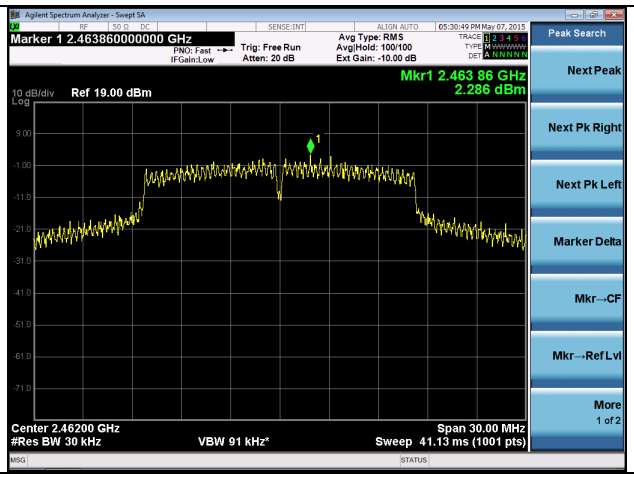


Power Spectral Density

High Channel – 2462 MHz

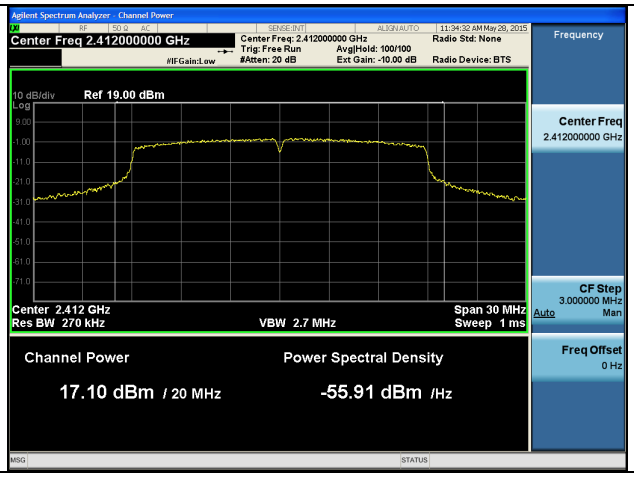


Output Power

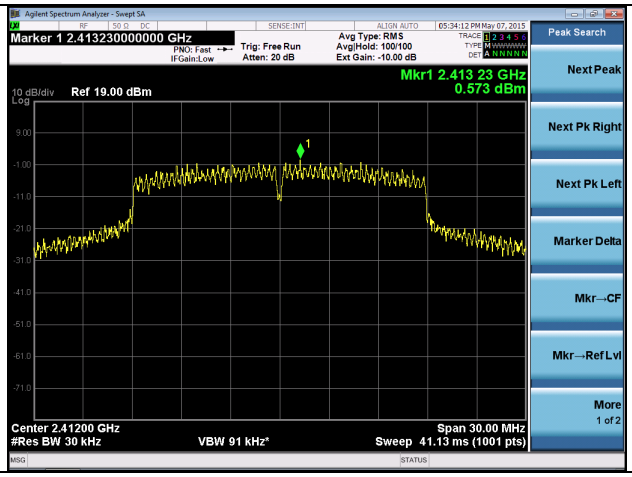


Power Spectral Density

802.11n – 6.5 Mbps
Low Channel – 2412 MHz

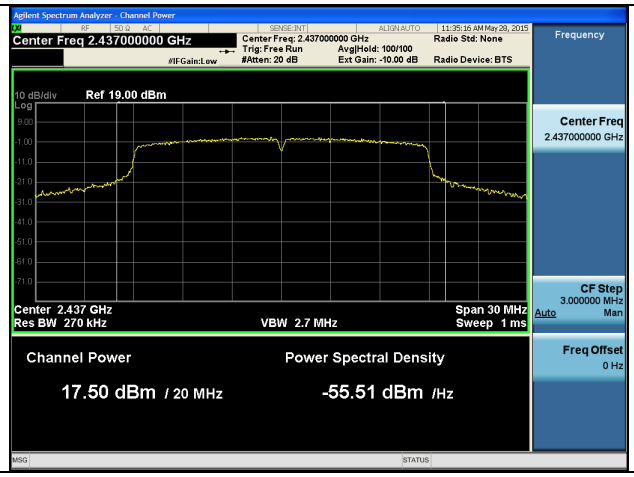


Output Power

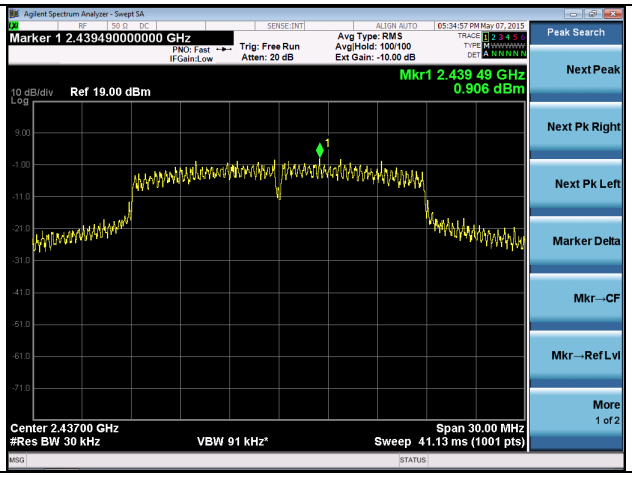


Power Spectral Density

Mid Channel – 2437 MHz

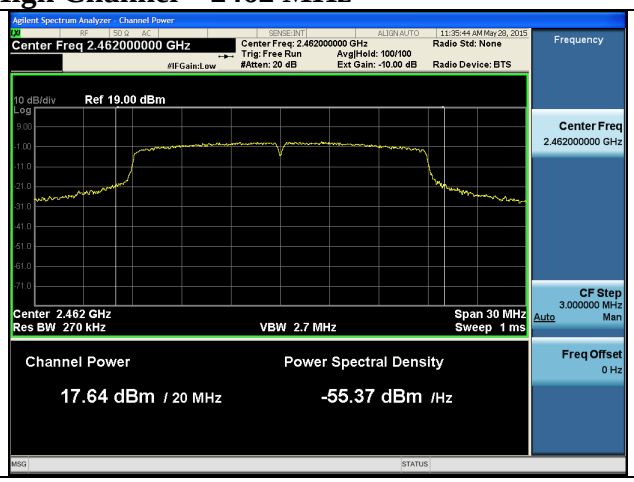


Output Power

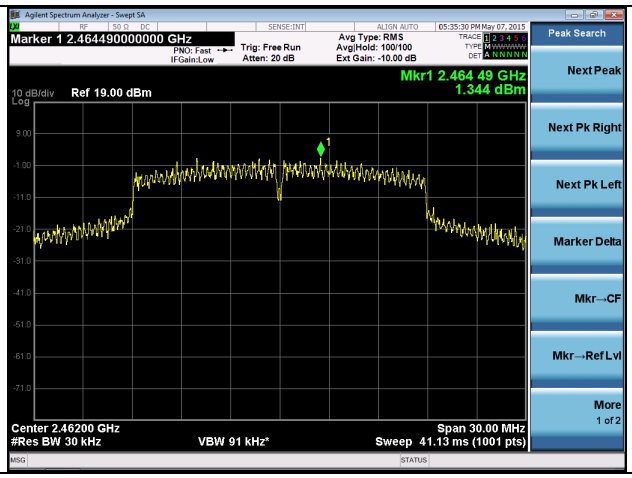


Power Spectral Density

High Channel – 2462 MHz



Output Power

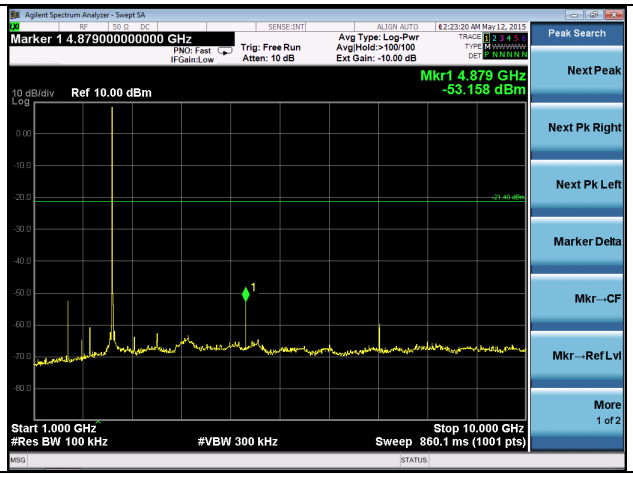


Power Spectral Density

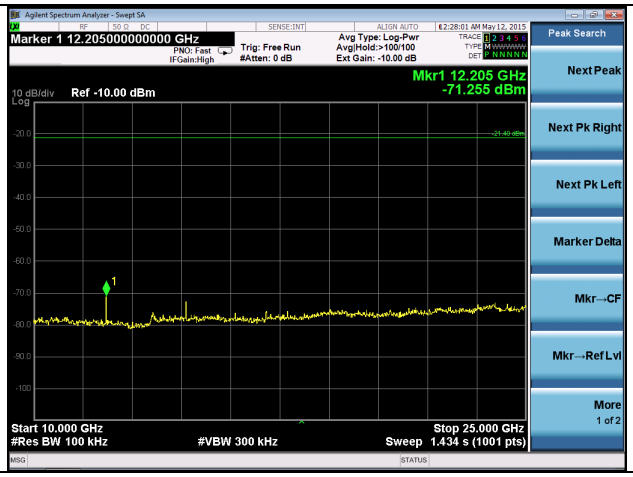
B.1.3 – RF Conducted – Transmitter Spurious Emissions

Manufacturer	JDSU
Date	5-7, 12 2015
Operator	Shane R.
Temp. / R.H.	20 - 25º C / 30-60% R.H.
Rule Part	FCC 15.247 (d) IC RSS-247 Section 5.5
Specific Measurement Procedure	ANSI C63.10-2013 Section 11.11
Additional Description of Measurement	RF Conducted Measurement
Additional Notes	1. Mid channel worst case data shown 2. Power measurements made with average method therefore emissions attenuated 30 dB relative in band PSD level. 3. For reference level measurement see DTS BW plots.

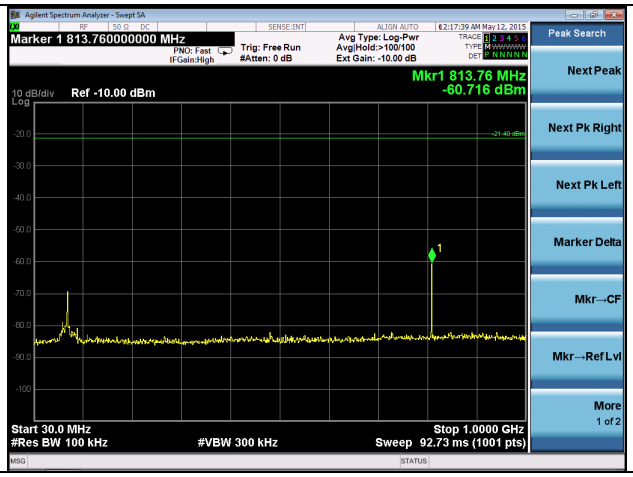
BLE



1 – 10 GHz

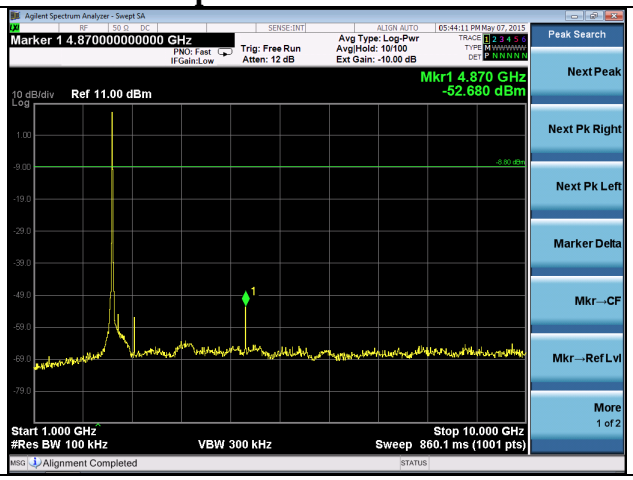


10-25 GHz

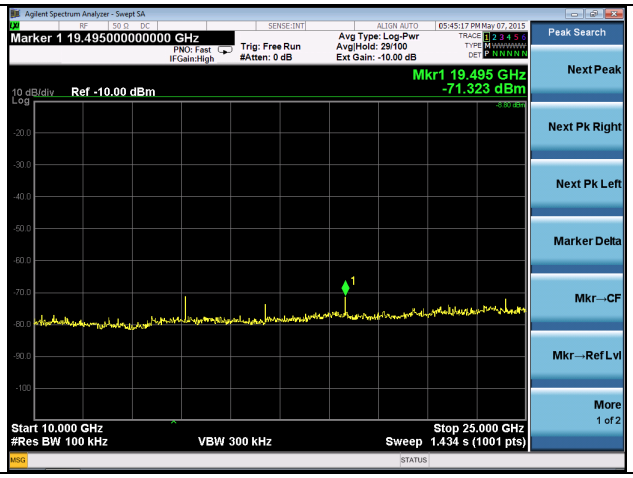


30-1000 MHz

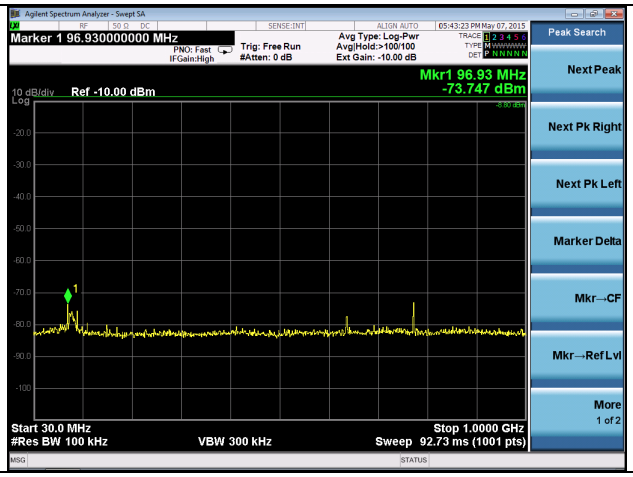
802.11b – 1 Mbps - Mid Channel – 2437 MHz



1 – 10 GHz

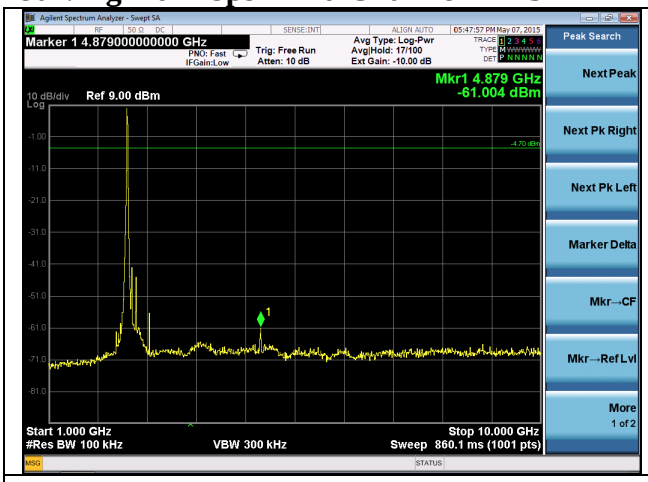


10-25 GHz

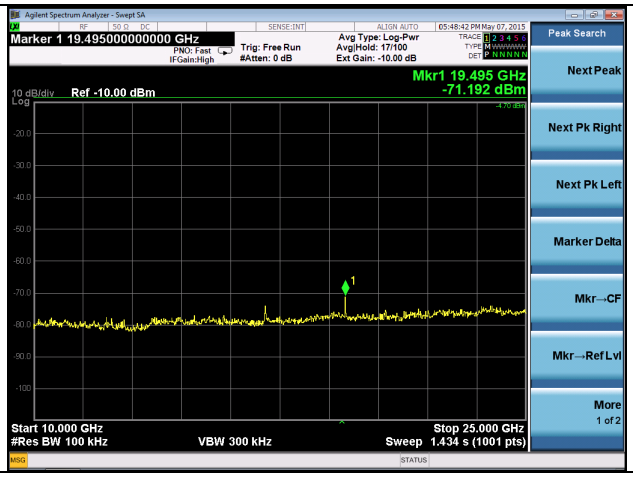


30-1000 MHz

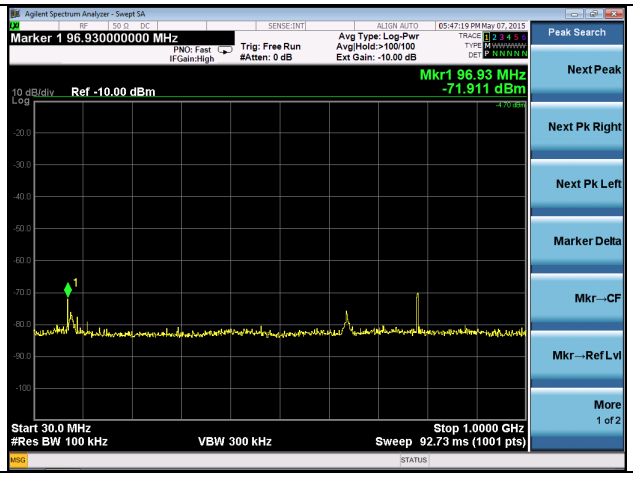
802.11g – 6 Mbps - Mid Channel – 2437 MHz



1 – 10 GHz

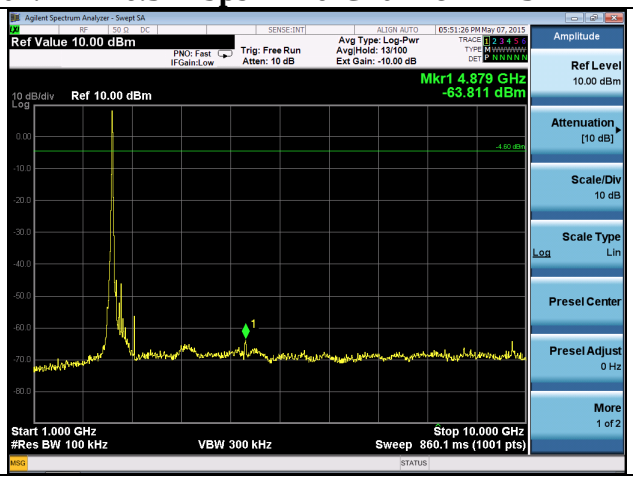


10-25 GHz

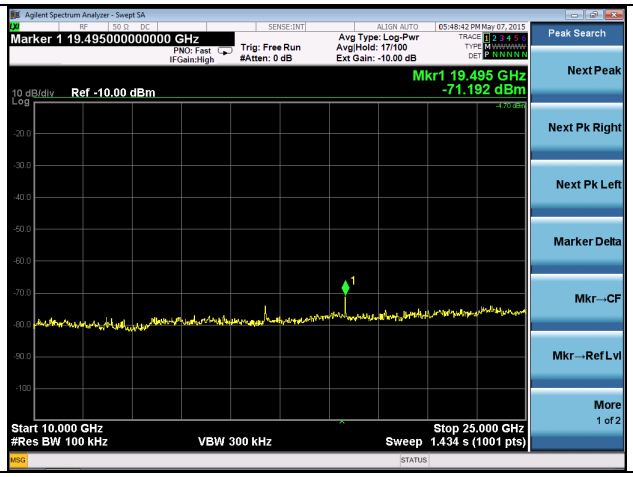


30-1000 MHz

802.11n – 6.5 Mbps - Mid Channel – 2437 MHz



1 – 10 GHz



10-25 GHz

30-1000 MHz

B.1.4 – RF Conducted – Frequency Stability

Manufacturer	JDSU
Date	5-15-15
Operator	Shane R.
Temp. / R.H.	20 - 25º C / 30-60% R.H.
Rule Part	FCC 2.1055 RSS-GEN Section 6.11
Specific Measurement Procedure	ANSI C63.10-2013 Section 6.8
Additional Description of Measurement	RF Conducted Measurement
Additional Notes	The power and frequency stability of the device was examined as a function of the input voltage available to the EUT. A Spectrum Analyzer was used to measure the RF output power and frequency at the appropriate frequency markers. Power was supplied by an external bench-type DC power supply and was varied from the nominal. The power was then cycled On/Off to observe system response. No unusual response was observed, the emission characteristics were well behaved, and the system returned to the same state of operation as before the power cycle. Below is data showing stability of the fundamental frequency. Continuous transmit un-modulated used for this test.

BLE

Channel	Supply voltage (DC)		Deviation (Hz)
	Nominal (7.4 VDC)	-15% (6.3 VDC)	
Low (Hz)	2401996039	2401996052	13
Middle (Hz)	2440995977	2440995978	1
High (Hz)	2479995921	2479995905	16

WLAN

Channel	Supply voltage (DC)		Deviation (Hz)
	Nominal (7.4 VDC)	-15% (6.3 VDC)	
Low (Hz)	2411996205	2411996182	23
Middle (Hz)	2436996084	2436996071	13
High (Hz)	2461996028	2461996048	20

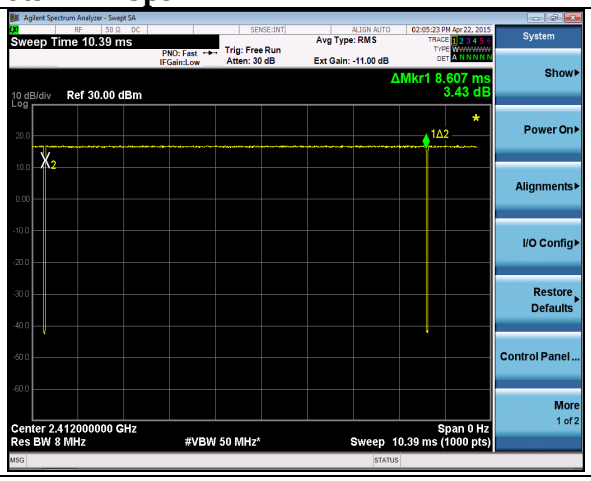
B.1.5 – RF Conducted – Duty Cycle

Manufacturer	JDSU
Date	4-22-15
Operator	Shane R.
Temp. / R.H.	20 - 25º C / 30-60% R.H.
Rule Part	N/A
Specific Measurement Procedure	ANSI C63.10-2013 Section 11.6
Additional Description of Measurement	RF Conducted Measurement
Additional Notes	Duty cycle used for average power and average PSD procedures

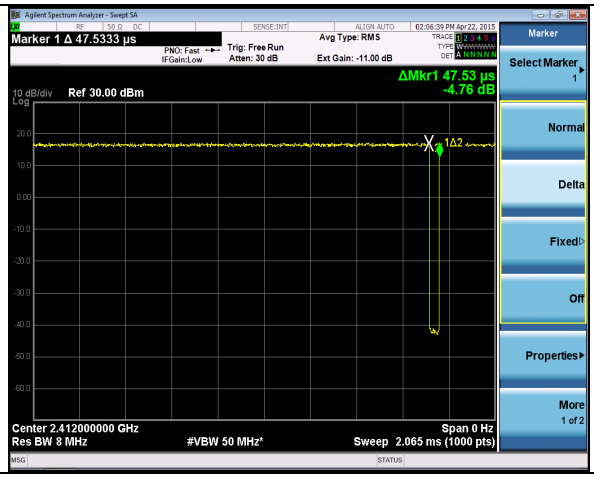
Table

Modulation	802.11 Standard	Data Rate (MBPS)	TX on time (ms)	TX off time (ms)	Duty Cycle	Duty cycle correction factor (dB)
DBPSK	b	1.0	8.607	0.047	0.99	0.0
BPSK	g	6.0	8.597	0.049	0.99	0.0
BPSK	n	MCS0	1.320	0.053	0.96	0.2

Plots - 1 Mbps

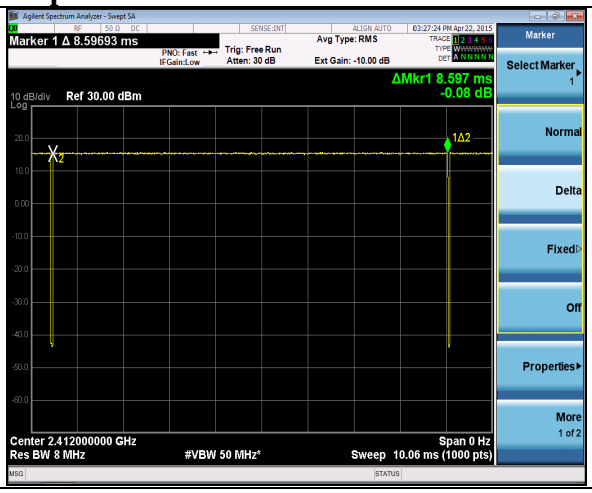


On-time

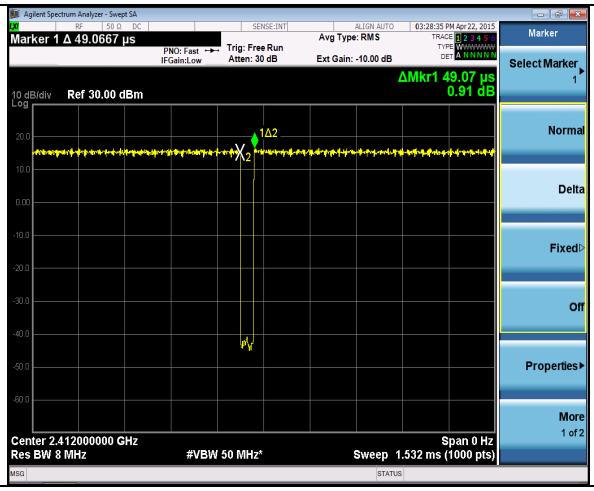


Off-time

6 Mbps

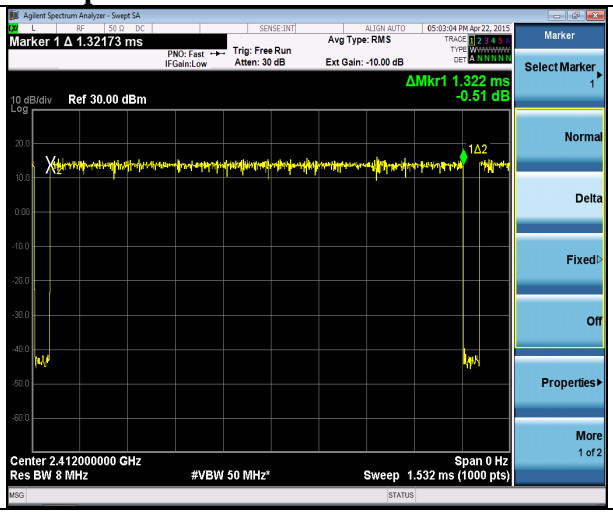


On-time

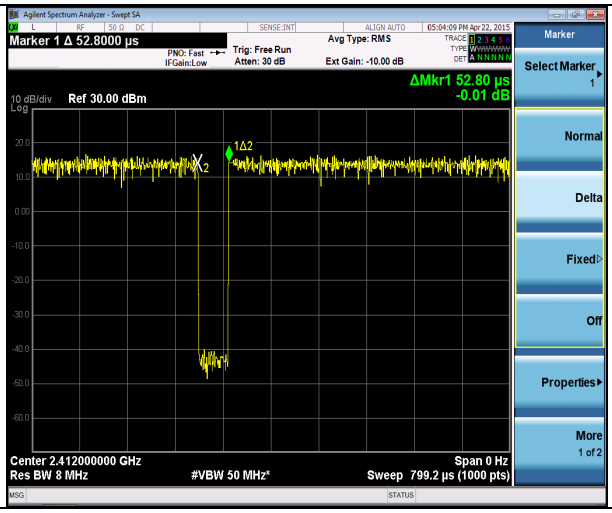


Off-time

6.5 Mbps



On-time



Off-time

B.2 – Transmitter Radiated Emissions in Restricted Bands

Rule Part(s)	FCC: 15.247 / 15.205 / 15.209 IC: RSS-GEN Section 8.9,8.10			
Measurement Procedure	ANSI C63.10 – 2013 Section 11.12 (6.3,6.5,6.6)			
Test Location	LS Research, LLC – FCC/IC Listed 3 meter Chamber			
Test Distance	See data section			
EUT Placement	Above 1 GHz: 150 cm height non-conductive table above reference ground plane covered with absorbers Below 1 GHz: 80 cm height non-conductive table above reference ground plane			
Frequency Range of Measurement	Biconical: 30-300 MHz	Log Periodic Dipole Array: 300-1000 MHz	Double-Ridged Waveguide Horn: 1-18 GHz	Standard Gain Horn: 18-26GHz
Measurement Detectors	30-1000MHz RBW: 120 kHz VBW: At least 300 kHz		1 - 40 GHz: RBW : 1MHz VBW: At least 3 MHz Peak VBW: ≤ 30 Hz Average	
Description of Measurement	1) The antenna, cable, pre-amp, and other necessary measurement system correction factors are loaded onto the EMI receiver / spectrum analyzer when the measurements are preformed. The data is gathered and reported as the corrected values. 2) The EUT is placed on a non-conductive pedestal centered on a turn-table in the test location with the antenna at the test distance from the EUT 3) Maximum radiated RF emissions are determined by rotation of azimuth and scanning the sense antenna between 1 and 4 meters in height using both horizontal and vertical antenna polarities. Maximized levels are manually noted at degree values of azimuth and at sense antenna height.			
Example Calculations	Reported Measurement data = Raw receiver measurement + Antenna Correction Factor + Cable factor (dB) - amplification factor (when applicable) + Additional factor (when applicable)			

Limits:

Frequency (MHz)	3 m Limit (µV/m)	3 m Limit (dBµV/m)	Type
30-88	100	40.0	Quasi-Peak
88-216	150	43.5	Quasi-Peak
216-960	200	46.0	Quasi-Peak
Above 960	500	54.0	Average (>1 GHz)

B.2.1 – Radiated Band-Edge Restricted Bands

Manufacturer	JDSU
Date	4-24, 4-27, 4-28 2015
Operator	Shane R.
Temp. / R.H.	20 - 25º C / 30-60% R.H.
Rule Part	FCC 15.247/ 15.205 / 15.209 IC RSS-247 / RSS-GEN
Measurement Procedure	ANSI C63.10-2013 Section 11.12
Test Distance	3 meter
EUT Placement	150 cm height non-conductive table centered on turn-table , absorbers covering ground plane
Detectors	Final Measurements: Peak / Max Hold, RBW 1 MHz, Average VBW 10Hz, Peak VBW 3 MHz
Additional Notes	1) EUT maximized in orientation, azimuth, and antenna height with maximum results reported.

Example Calculation:
Limit (dBµV/m) – Reading (dBµV/m) = Margin (dB)

Table

Mode	Channel	Frequency (GHz)	Meas (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas Type	Limit Type
BLE	0	2.38680	47.36	54	6.6	Peak	Average
	78	2.48435	48.07	54	5.9	Peak	Average

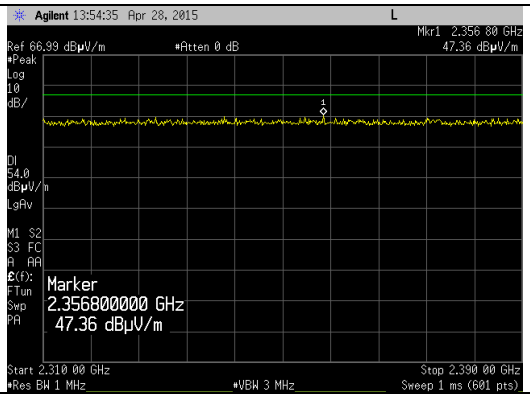
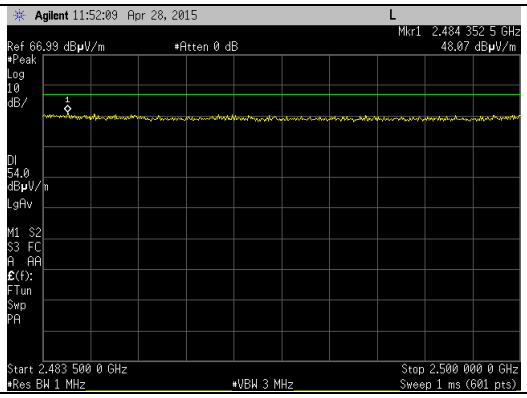
Average

Mode (802.11)	Mode (Mbps)	Channel	Frequency (GHz)	Avg Meas (dBµV/m)	Avg Limit (dBµV/m)	Margin (dB)
b	1	1	2.38373	37.61	54	16.4
		11	2.48350	45.29		8.7
g	6	1	2.39000	42.99		11.0
		11	2.48350	50.97		3.0
n	6.5	1	2.39000	44.18		9.8
		11	2.48350	51.91		2.1

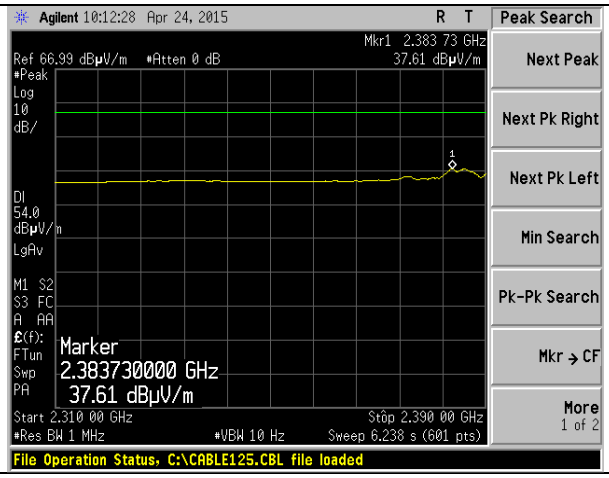
Peak

Mode (802.11)	Mode (Mbps)	Channel	Frequency (GHz)	Avg Meas (dBµV/m)	Avg Limit (dBµV/m)	Margin (dB)
b	1	1	2.34400	61.33	74	12.7
		11	2.48378	59.13		14.9
g	6	1	2.38973	63.31		10.7
		11	2.48386	68.87		5.1
n	6.5	1	2.39000	70.85		3.2
		11	2.48375	73.11		0.9

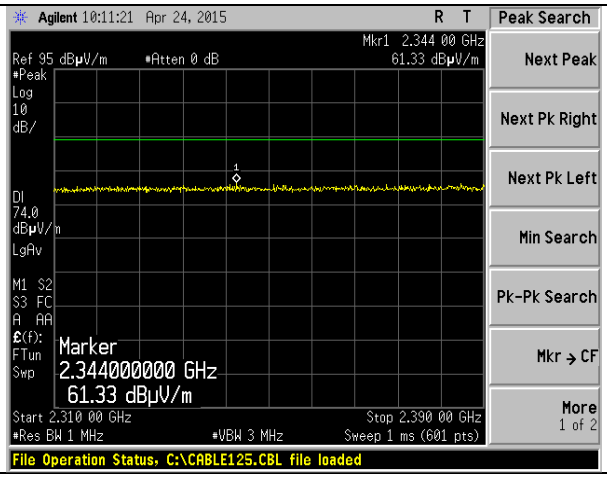
Plots – BLE

	
1 Mbps	6 Mbps

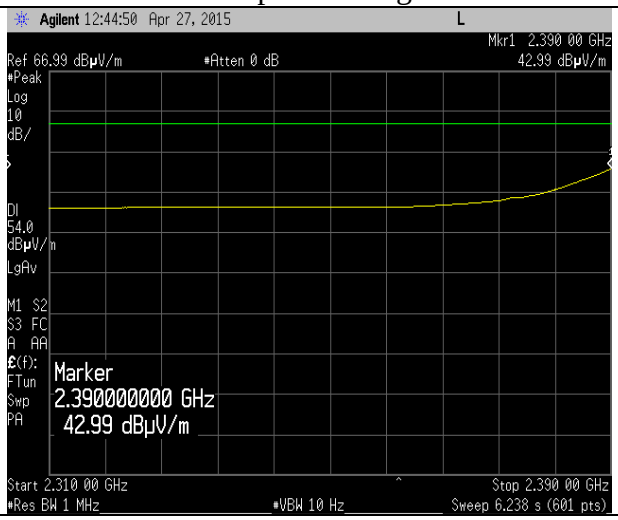
Plots – WLAN Low Channel



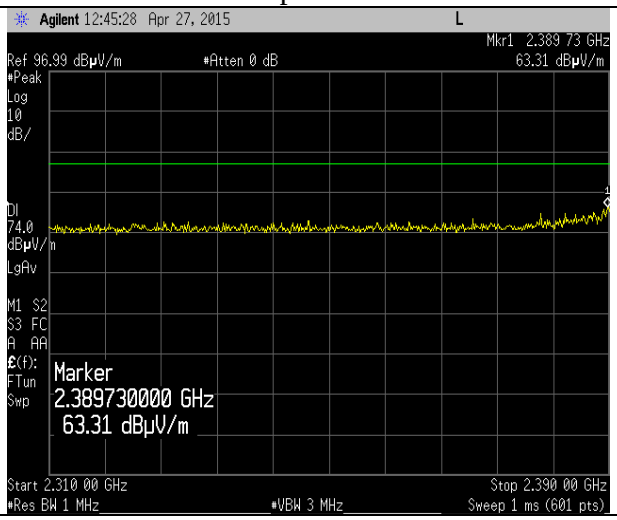
1 Mbps – Average



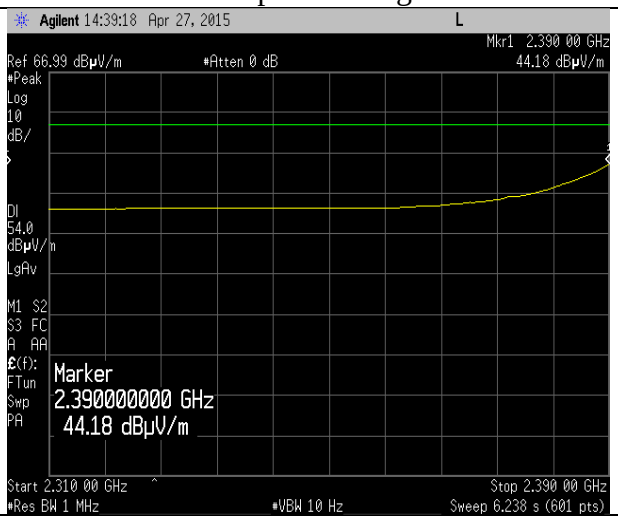
1 Mbps – Peak



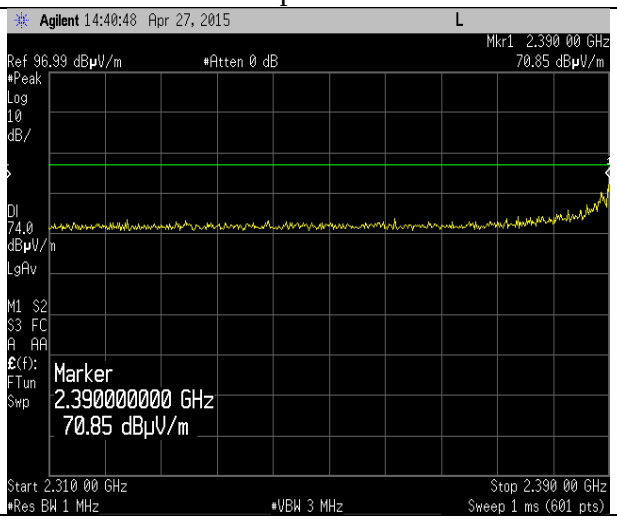
6 Mbps – Average



6 Mbps – Peak

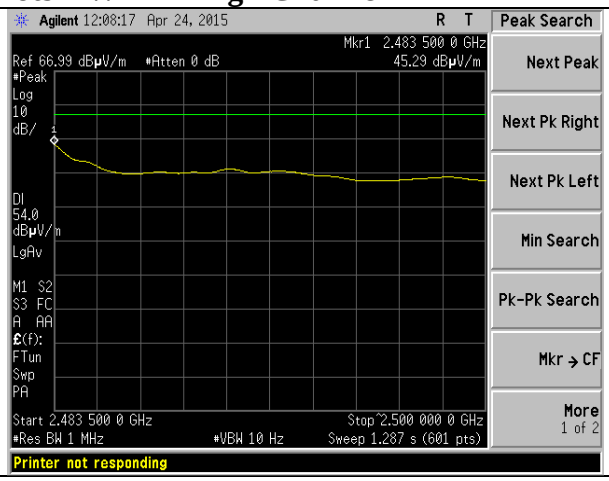


6.5 Mbps – Average

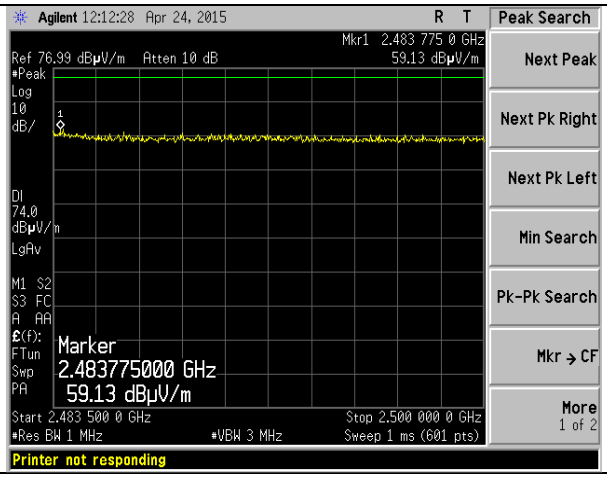


6.5 Mbps – Peak

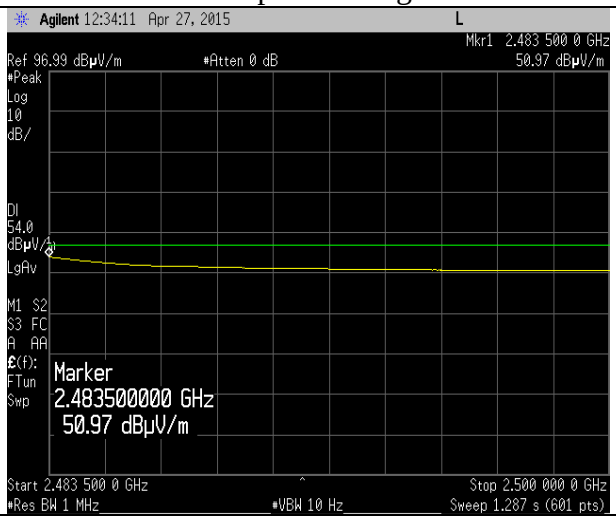
Plots – WLAN High Channel



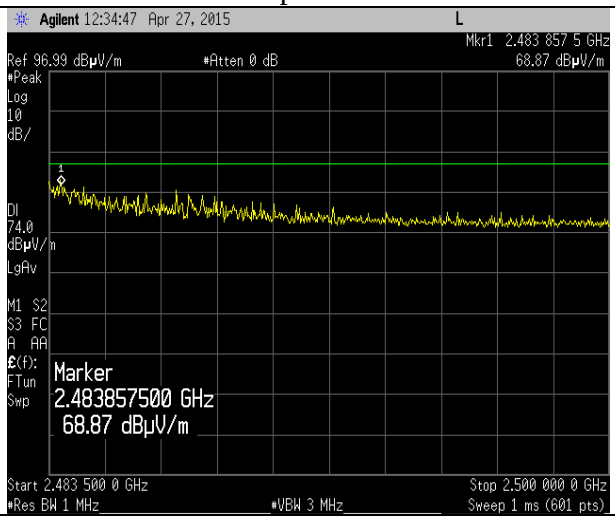
1 Mbps – Average



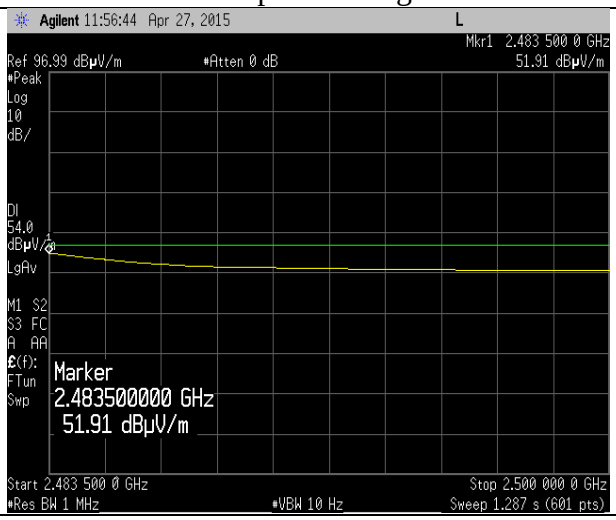
1 Mbps – Peak



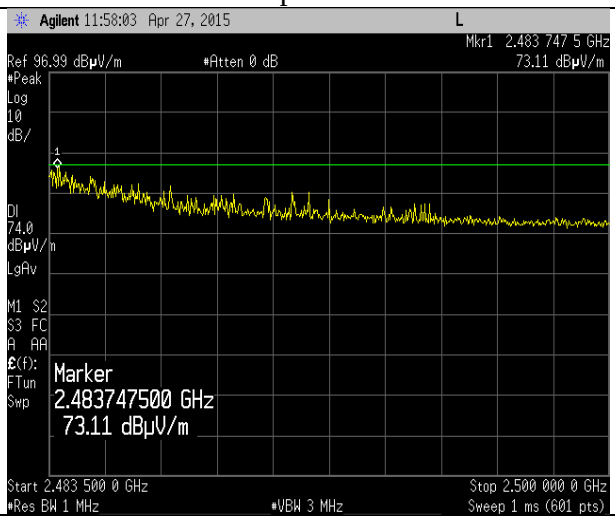
6 Mbps – Average



6 Mbps – Peak



6.5 Mbps – Average



6.5 Mbps – Peak

B.2.2 – Radiated Harmonics in Restricted Bands

Manufacturer	JDSU
Date	5-6-15
Operator	Shane R.
Temp. / R.H.	20 - 25º C / 30-60% R.H.
Rule Part	FCC 15.247/ 15.205 / 15.209 IC RSS-247 / RSS-GEN
Measurement Procedure	ANSI C63.10-2013 Section 11.12
Test Distance	3 meter
EUT Placement	150 cm height non-conductive table centered on turn-table , absorbers covering ground plane
Detectors	Final Measurements: Peak / Max Hold, RBW 1 MHz, Peak VBW 3 MHz
Additional Notes	1) EUT maximized in orientation, azimuth, and antenna height with maximum results reported. 2) Worst case mode (1 Mbps) measured. 3) *Refer to Appendix E for duty cycle correction. (14.9 dB)

Example Calculation:
Peak Limit (74 dBµV/m @ 3m) – Peak Reading (dBµV/m) = Peak Margin (dB)
Peak Reading (dBµV/m) – Duty Cycle* (dB) = Calculated Average (dBµV/m)
Average Limit (54 dBµV/m @ 3m) – Calculated Average (dBµV/m) = Average Margin (dB)
or
Average Limit (54 dBµV/m @ 3m) – Average Reading (dBµV/m) = Average Margin (dB)

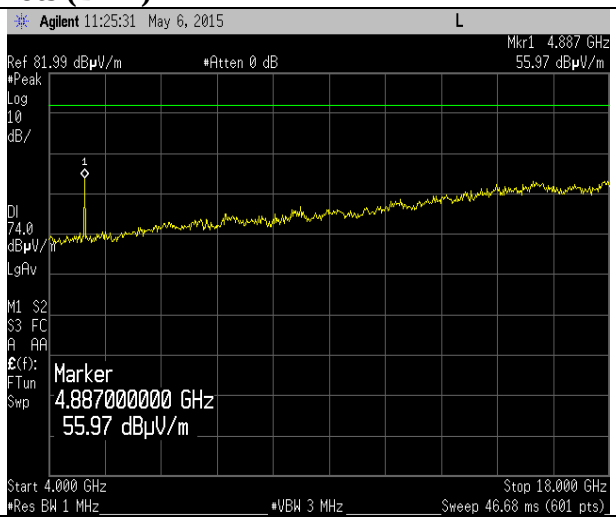
Table (BLE)

EUT Channel	Frequency (MHz)	EUT orientation	Antenna Polarity	Height (cm)	Azimuth (degree)	Peak Reading (dBµV/m)	Calculated Average (dBµV/m)	Peak Margin (dB)	Average Margin (dB)
Low	4804	Vertical	Horizontal	140	195	47.4	32.5	26.6	21.5
			Vertical	105	158	50.6	35.7	23.4	18.3
		Side	Horizontal	125	121	48.1	33.2	25.9	20.8
			Vertical	100	151	48.1	33.2	25.9	20.8
		Flat	Horizontal	160	90	47.6	32.7	26.4	21.3
			Vertical	132	166	49.3	34.4	24.7	19.6
Mid	4882	Vertical	Horizontal	100	157	57.4	42.5	16.6	11.5
			Vertical	128	212	51.0	36.1	23.0	17.9
		Side	Horizontal	108	150	52.8	37.9	21.2	16.1
			Vertical	100	140	55.5	40.6	18.5	13.4
		Flat	Horizontal	144	100	52.1	37.2	21.9	16.8
			Vertical	118	128	54.5	39.6	19.5	14.4
High	4960	Vertical	Horizontal	163	150	58.8	43.9	15.2	10.1
			Vertical	100	204	52.5	37.6	21.5	16.4
		Side	Horizontal	135	151	54.5	39.6	19.5	14.4
			Vertical	118	154	57.1	42.2	16.9	11.8
		Flat	Horizontal	146	95	55.2	40.3	18.8	13.7
			Vertical	164	187	55.4	40.5	18.6	13.5

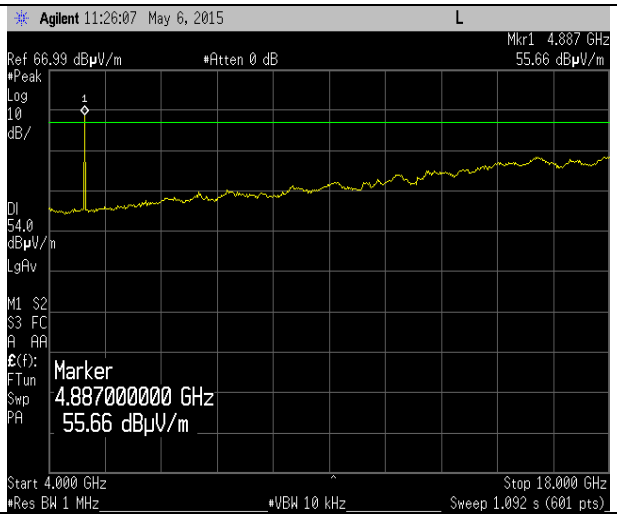
Table (WLAN)

EUT Channel	Frequency (MHz)	EUT orientation	Antenna Polarity	Height (cm)	Azimuth (degree)	Peak Reading (dBµV/m)	Average Reading (dBµV/m)	Peak Margin (dB)	Average Margin (dB)
Low	4824	Vertical	Horizontal	160	153	46.2	40.7	27.8	13.3
			Vertical	100	207	45.7	35.9	28.3	18.1
		Side	Horizontal	216	0	43.4	35.0	30.6	19.0
			Vertical	114	347	44.7	37.6	29.3	16.4
		Flat	Horizontal	150	262	44.4	35.3	29.6	18.7
			Vertical	200	220	44.1	36.8	29.9	17.2
Mid	4874	Vertical	Horizontal	100	145	44.7	37.4	29.3	16.6
			Vertical	100	187	42.9	33.5	31.1	20.5
		Side	Horizontal	100	154	43.6	33.0	30.4	21.0
			Vertical	100	132	44.5	37.1	29.5	16.9
		Flat	Horizontal	120	95	44.4	33.9	29.6	20.1
			Vertical	100	188	44.2	34.5	29.8	19.5
High	4924	Vertical	Horizontal	100	160	46.2	40.7	27.8	13.3
			Vertical	100	202	42.2	34.1	31.8	19.9
		Side	Horizontal	100	151	44.0	35.2	30.0	18.8
			Vertical	100	160	45.9	39.9	28.1	14.1
		Flat	Horizontal	100	90	44.8	35.7	29.2	18.3
			Vertical	108	186	43.9	35.5	30.1	18.5

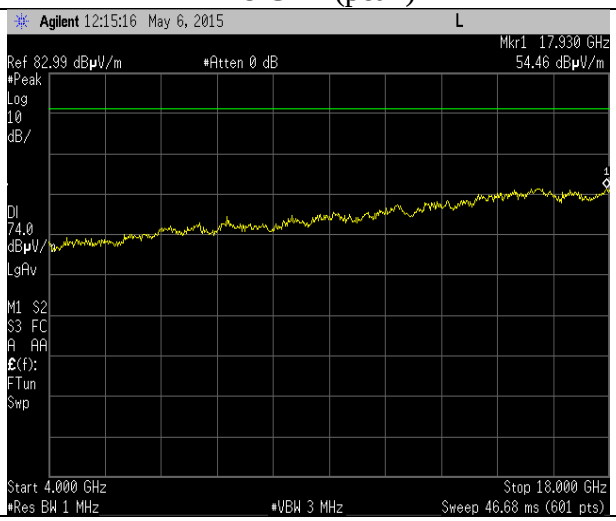
Plots (BLE)



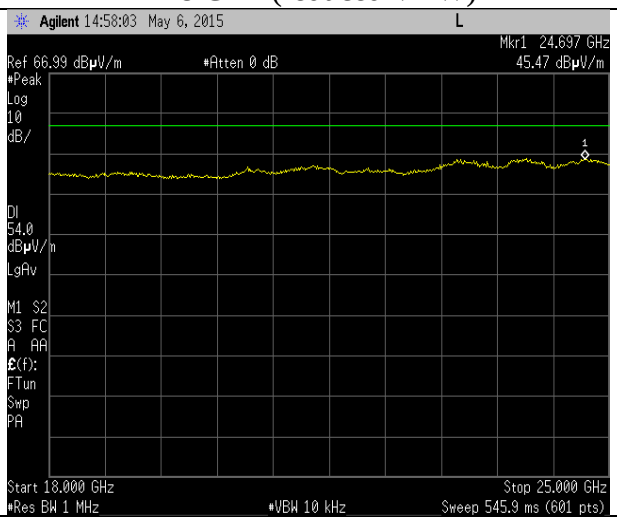
4-18 GHz (peak)



4-18 GHz (reduced VBW)

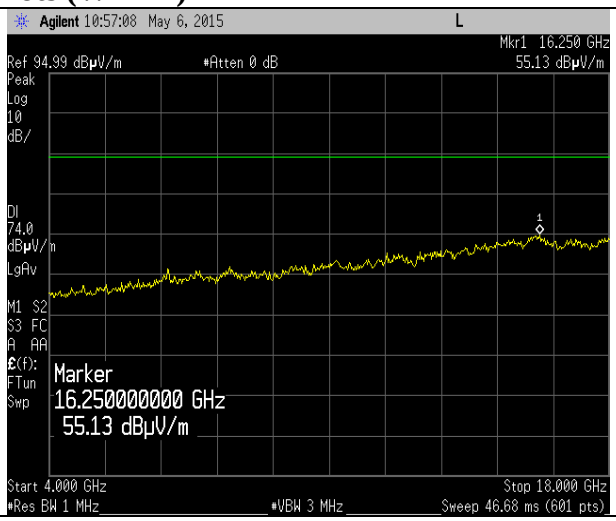


18-25 GHz (peak)

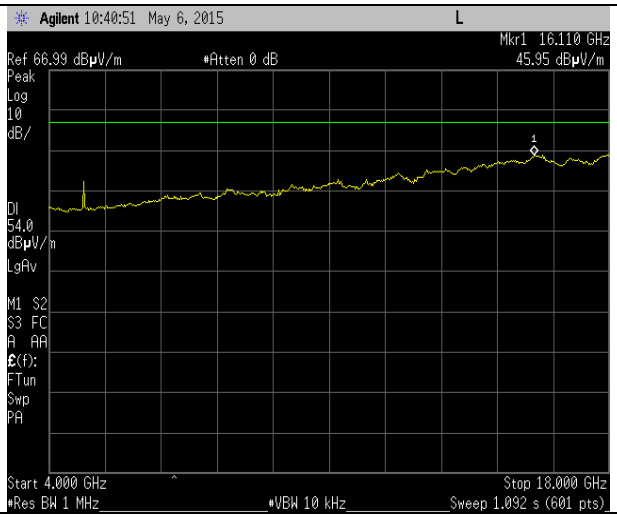


18-25 GHz (reduced VBW)

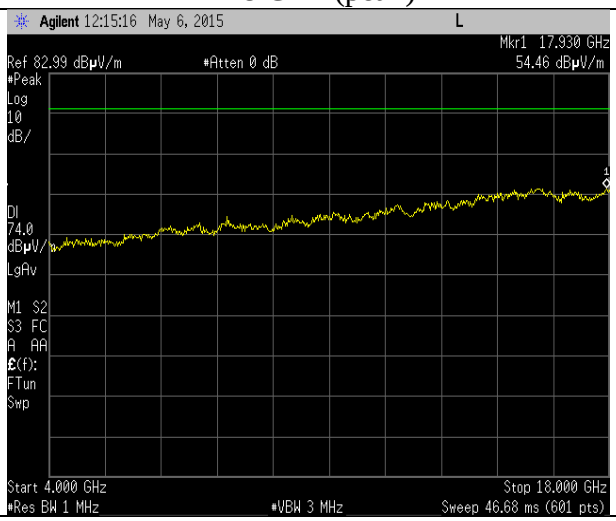
Plots (WLAN)



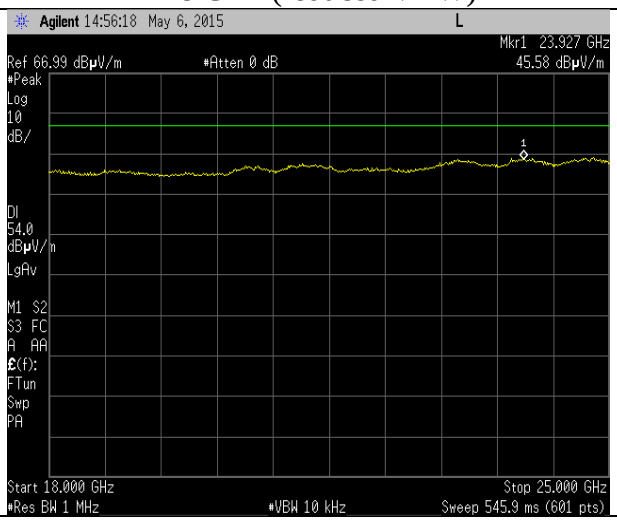
4-18 GHz (peak)



4-18 GHz (reduced VBW)



18-25 GHz (peak)

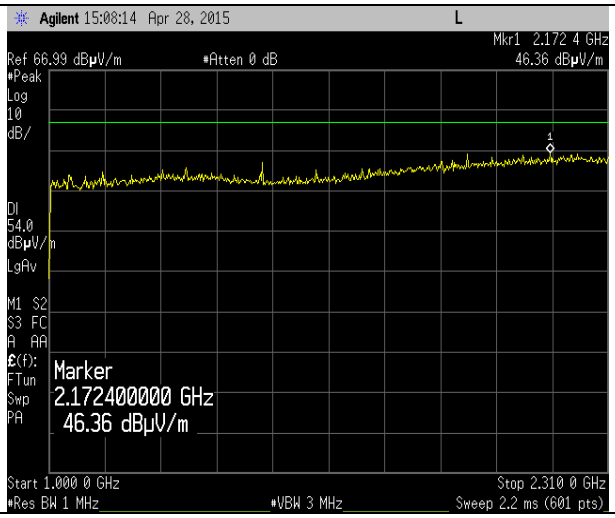


18-25 GHz (reduced VBW)

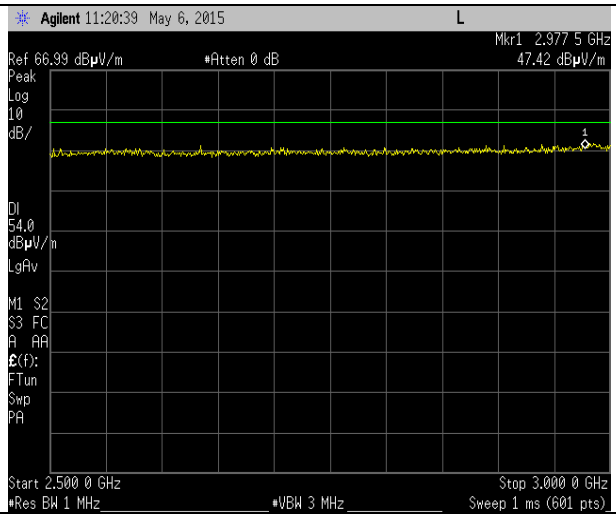
B.2.3 – Radiated Spurious Emissions Transmit Mode (1-26 GHz)

Manufacturer	JDSU
Date	4-28, 5-6 2015
Operator	Shane R.
Temp. / R.H.	20 - 25º C / 30-60% R.H.
Rule Part	FCC 15.247/ 15.205 / 15.209 IC RSS-247 / RSS-GEN
Measurement Procedure	ANSI C63.10-2013 Section 6.3, 6.6
Test Distance	3 meter 1-18 GHz
EUT Placement	150 cm height non-conductive table centered on turn-table , absorbers covering ground plane
Detectors	Peak; RBW 1 MHz
Additional Notes	1) EUT maximized in orientation, azimuth, and antenna height with maximum results reported. 2) No Emissions found above system noise floor for BLE or WLAN. 3) Frequency ranges 2310-2390 MHz, 2483.5-2500 MHz, and 4-25 GHz seen in previous sections.

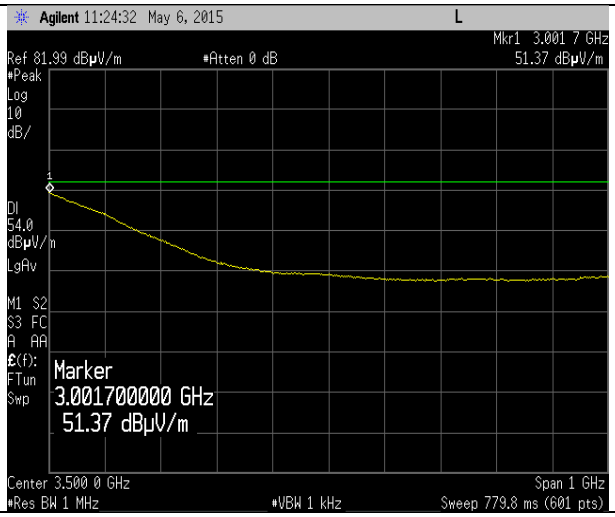
Plots



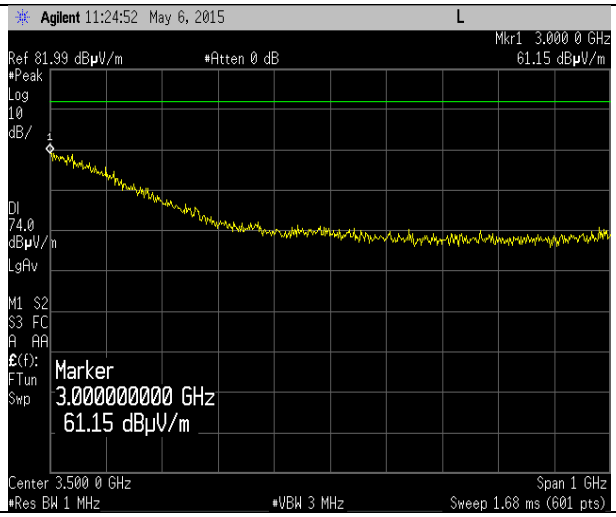
1-2.31 GHz



2.5-3 GHz



3-4 GHz (Reduced VBW)



3-4 GHz Peak)

B.2.4 – Radiated Spurious Emissions Transmit Mode (30-1000 MHz)

Manufacturer	JDSU
Date	6-19-15
Operator	Adam A
Temp. / R.H.	20 - 25º C / 30-60% R.H.
Rule Part	FCC 15.247/ 15.205 / 15.209 IC RSS-247 / RSS-GEN
Measurement Procedure	ANSI C63.10-2013 Section 6.3, 6.5
Test Distance	3 meter 30-1000 MHz
EUT Placement	80 cm height non-conductive table centered on turn-table (no absorbers on ground plane)
Detectors	Peak; RBW 120 kHz
Additional Notes	1) Tested in continuous transmit modulated mode with EUT in three orientations at maximum power. 2) Emissions not effected by channel or modulation for BLE or WLAN

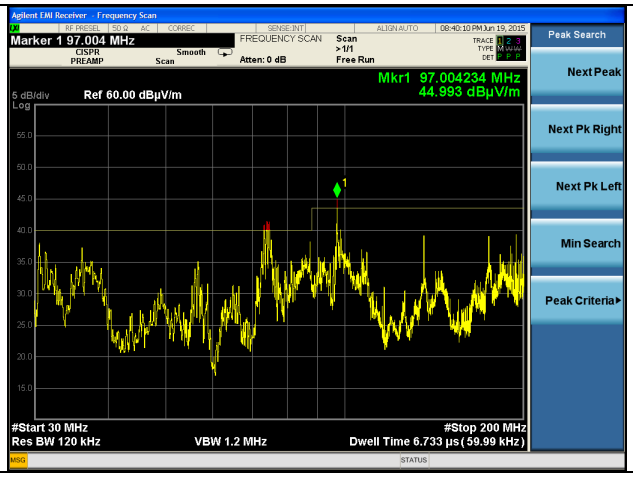
Example Calculation:

Limit (dBµV/m) – Reading (dBµV/m) = Margin

Table

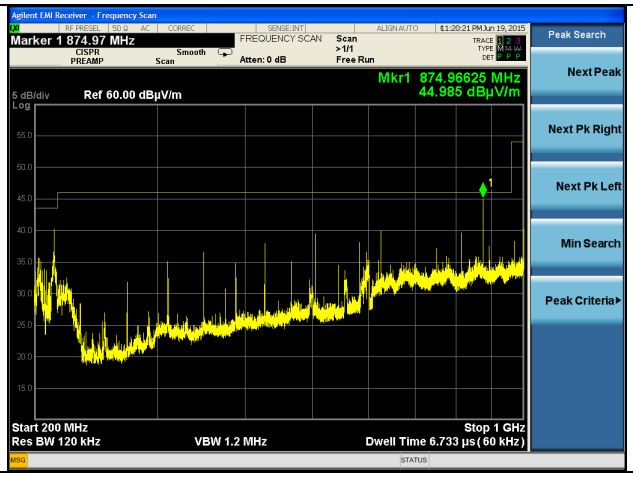
Frequency (MHz)	Antenna Polarity	Height (cm)	Azimuth (degree)	Quasi-Peak Reading (dBµV/m)	Quasi-Peak Limit (dBµV/m)	Margin (dB)
97.0	Vertical	100	0	40.7	43.5	2.8
73.9	Vertical	100	257	38.4	40.0	1.6
31.4	Vertical	100	187	33.5	40.0	6.5
135.8	Horizontal	314	252	39.2	43.5	4.3
97.0	Horizontal	218	90	38.5	43.5	5.0
174.5	Horizontal	179	126	38.1	43.5	5.4
875.0	Vertical	126	16	44.4	46.0	1.6
213.4	Vertical	100	159	34.5	43.5	9.0
625.0	Vertical	100	0	39.0	46.0	7.0
698.2	Horizontal	121	0	39.9	46.0	6.1
504.2	Horizontal	201	300	40.9	46.0	5.1
426.6	Horizontal	195	0	39.3	46.0	6.7

Plots

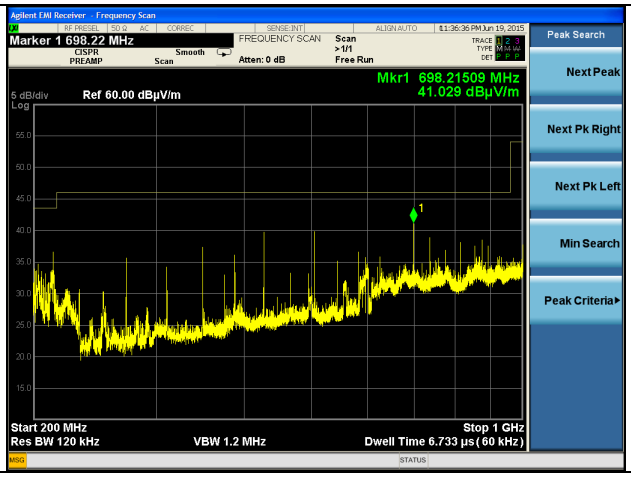


30-200 MHz Vertical

30-200 MHz Horizontal



200-1000 MHz Vertical



200-1000 MHz Horizontal

B.3 – AC Mains Conducted Emissions

Rule Part(s)	FCC: 15.207 / 15.107 IC: RSS-247 / RSS-GEN
Measurement Procedure	ANSI C63.4 - 2014 ANSI C63.10 – 2013
Test Location	LS Research, LLC – Conducted Emissions Area
Test Voltage	120 VAC 60 Hz
EUT Placement	80 cm height non-conductive table above reference ground plane
Frequency Range of Measurement	150 kHz – 30 MHz
Measurement Detectors	Peak, Quasi-Peak, Average RBW: 9 kHz VBW: At least 27 kHz
Description of Measurement	1) The LISN, cable, limiter, and other necessary measurement system correction factors are loaded onto the EMI receiver / spectrum analyzer when the measurements are preformed. The data is gathered and reported as the corrected values. 2) The EUT is placed on a non-conductive pedestal at appropriate distance from ground planes and plugged into LISN. The LISN used has the ability to terminate the unused port with a 50Ω (ohm) load when switched to either L1 (line) or L2 (neutral). 3) Maximum emissions are determined with peak detector and measurements at select points are made with quasi-peak and average detectors. Results are recorded and compared to limit.
Example Calculations	Reported Measurement data = Raw receiver measurement + LISN Factor + Cable factor (dB) + Additional factor (when applicable)

Limits of Conducted Emissions at the AC Mains Ports:

Frequency Range (MHz)	Class B Limits (dBµV)	
	Quasi-Peak	Average
0.150 -0.50 *	66-56	56-46
0.5 – 5.0	56	46
5.0 – 30	60	50
* The limit decreases linearly with the logarithm of the frequency in this range.		

B.4.1 – AC Mains Conducted Emissions

Manufacturer	JDSU
Date	6-22-15
Operator	Adam A
Temp. / R.H.	20 - 25º C / 30-60% R.H.
Rule Part	15.207 / 15.107 / RSS-GEN
Measurement Procedure	ANSI C63.4 - 2014 ANSI C63.10 - 2013 Section 6.2
Test Voltage	120 VAC 60 Hz supplied to AC adapter supplied by applicant for use with EUT
EUT Placement	80 cm height non-conductive table, 40 cm from vertical ground plane
Detectors	Peak; RBW 9 kHz Quasi-Peak and Average
Additional Notes	1) Tested in continuous transmit and receive with no significant difference between operating channels BLE or WLAN. WLAN Channel 6, 1 MBPS for final data.

Example Calculation:

Margin (dB) = Limit (dBµV) – Reading (dBµV)

Table

Frequency (MHz)	Line	Peak Reading (dBµV)	Quasi-Peak Reading (dBµV)	Average Reading (dBµV)	Q-Peak Limit (dBµV)	Quasi-Peak Margin (dB)	Average Limit (dBµV)	Average Margin (dB)
0.150	1	52.6	47.4	34.7	66.00	18.6	56.00	21.3
0.222	1	47.7	41.0	30.6	62.74	21.7	52.74	22.1
0.469	1	43.3	39.3	30.0	56.53	17.2	46.53	16.5
6.193	1	38.4	34.9	28.6	60.00	25.1	50.00	21.4
6.445	1	38.1	34.4	27.9	60.00	25.6	50.00	22.1
0.177	1	49.3	43.0	32.7	64.63	21.6	54.63	21.9
0.163	2	50.0	45.8	32.2	65.31	19.5	55.31	23.1
0.190	2	46.2	42.4	29.0	64.04	21.6	54.04	25.0
0.469	2	43.2	40.0	29.9	56.53	16.5	46.53	16.6
0.437	2	41.5	37.9	29.2	57.12	19.2	47.12	17.9
6.179	2	38.6	35.9	29.7	60.00	24.1	50.00	20.3
6.449	2	38.5	35.8	29.5	60.00	24.2	50.00	20.5

Plots

Line 1

Line 2

Appendix C - Uncertainty Summary

This uncertainty represents an expanded uncertainty expressed at approximately the 95 % confidence level, using a coverage factor of k=2.

Table of Expanded Uncertainty Values, (K=2) for Specified Measurements

Measurement Type	Particular Configuration	Uncertainty Values
Radiated Emissions	3 – Meter chamber, Biconical Antenna	4.82 dB
Radiated Emissions	3-Meter Chamber, Log Periodic Antenna	4.88 dB
Radiated Emissions	3-Meter Chamber, Horn Antenna	4.85 dB
Absolute Conducted Emissions	Agilent PSA/ESA Series	1.38 dB
AC Line Conducted Emissions	Shielded Room/EMCO LISN	3.20 dB
Radiated Immunity	3 Volts/Meter in 3-Meter Chamber	2.05 Volts/Meter
Conducted Immunity	3 Volts level	2.33 V
EFT Burst, Surge, VDI	230 VAC	54.4 V
ESD Immunity	Discharge at 15kV	3200 V
Temperature/Humidity	Thermo-hygrometer	0.64°/ 2.88 %RH

Appendix D - References

Publication	Year	Title
FCC CFR Parts 0-15	2015	Code of Federal Regulations – Telecommunications
RSS-247 Issue 1	2015	Digital Transmissions Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices
RSS-GEN Issue 4	2014	General Requirements and Information for the Certification of Radio Apparatus
ANSI C63.4	2014	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.
ANSI C63.10	2013	American National Standard of Procedures for Compliance Testing Unlicensed Wireless Devices

Appendix E – Duty Cycle Calculation

1.0 Summary

There are directed and undirected advertising events.

The worst case relaxation factor for a directed advertising event is 14.9 dB.
The worst case relaxation factor for an undirected advertising event is 20 dB.

1.1 Defining Packet Length

2.1 PACKET FORMAT

The Link Layer has only one packet format used for both advertising channel packets and data channel packets.

The packet format is shown in Figure 2.1. Each packet consists of four fields: the preamble, the Access Address, the PDU, and the CRC.

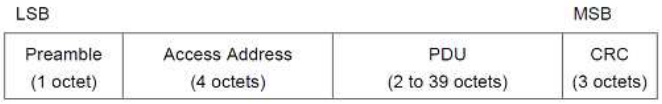


Figure 2.1: Link Layer packet format

The preamble is 1 octet and the Access Address is 4 octets. The PDU range is from 2 to a maximum of 39 octets. The CRC is 3 octets.

The Preamble is transmitted first, followed by the Access Address, followed by the PDU followed by the CRC.

The shortest packet is 80 bits in length. The longest packet is 376 bits in length.

PDU Type $b_3b_2b_1b_0$	Packet Name
0000	ADV_IND
0001	ADV_DIRECT_IND
0010	ADV_NONCONN_IND
0011	SCAN_REQ
0100	SCAN_RSP
0101	CONNECT_REQ
0110	ADV_SCAN_IND
0111-1111	Reserved

Table 2.1: Advertising channel PDU Header's PDU Type field encoding

Octets per Packet
ADV_IND = 37 octets
ADV_DIRECT_IND = 12 octets
ADV_NONCONN_IND =37 octets
SCAN_REQ = 12 octets
SCAN_RSP = 37 octets
CONNECT_REQ = 34 octets
ADV_SCAN_IND = 37 octets

Preamble (1)	Access Address (4)	PDU Header (2)	Worst Case PDU Type (37)	CRC (3)

Stated worst case length packet: 47 octets = 376 bits
Worst Case Packet Duration: 376 bits * 1 µS / bit = 376 µS

1.2 Defining Inter Frame Space

4.1 INTER FRAME SPACE

The time interval between two consecutive packets on the same channel index is called the Inter Frame Space. It is defined as the time from the end of the last bit of the previous packet to the start of the first bit of the subsequent packet. The Inter Frame Space is designated "T_IFS" and shall be 150 µs.

1.3 Defining Undirected Advertising Event

For all undirected advertising events, the time between the start of two consecutive advertising events (*T_advEvent*) is computed as follows for each advertising event:

T_advEvent = advInterval + advDelay

The *advInterval* shall be an integer multiple of 0.625 ms in the range of 20 ms to 10.24 s. If the advertising event type is either a scannable undirected event type or a non-connectable undirected event type, the *advInterval* shall not be less than 100 ms. If the advertising event type is a connectable undirected event type, the *advInterval* can be 20 ms or greater.

The *advDelay* is a pseudo-random value with a range of 0 ms to 10 ms generated by the Link Layer for each advertising event.

As illustrated in Figure 4.1, the advertising events are perturbed in time using the advDelay.

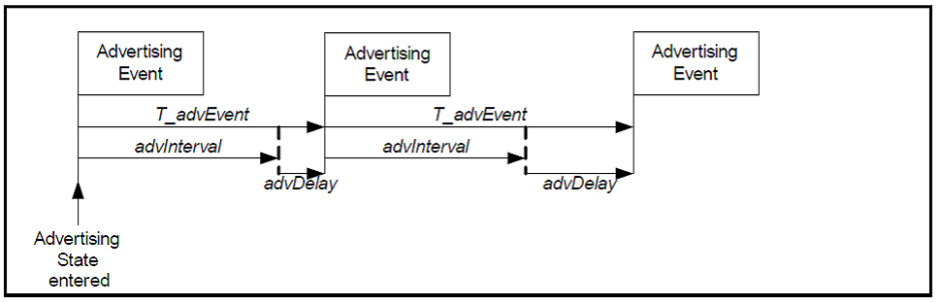


Figure 4.1: Advertising events perturbed in time using advDelay

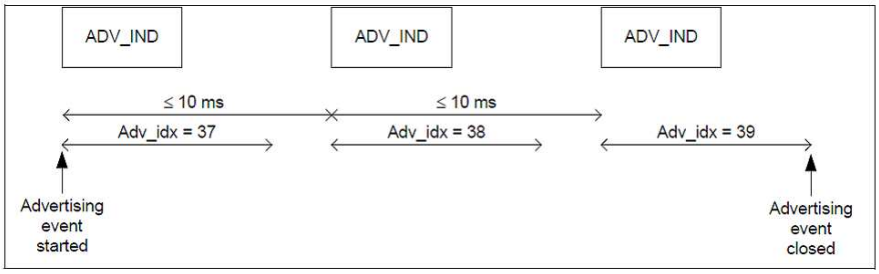


Figure D2: Connectable undirected advertising event with only advertising PDUs

1.3.1 Duty Factor for Connectable Undirected Advertising Event, per advertising channel:

ADV_IND = 376 µS duration (ON channel 37)
IFS = 150 µS (OFF)
ADV_IND = 376 µS duration (OFF channel 38)
IFS =150 µS (OFF)
ADV_IND = 376 µS duration (OFF Channel 39).
advInterval (min) = 20 mS

1.3.1.1 Straight Duty Factor

DF = 376 / (376*3+150*2+20000) =0.0175
Relaxation factor =-min (20*log10 (DF),-20 dB) =-min (-35.119,-20) = 20 dB

1.3.1.2 Duty Factor in 100mS window:

Packet Repetition Interval is (376*3) + (2*150) + 20000 microseconds =21428 microseconds
Number of Packet Repetitions per 100 mS window = 21428/100000 = 4.667 Packet Intervals
This will result in 5 packets being transmitted in a 100 mS window.

DF (rel 100 mS) = (5*376) / (100000) = 0.0188
Relaxation Factor Relative to 100 mS = - Max (20*log10 (DF (rel 100mS)),-20 dB) = -Max (-34.51 dB, -20) = 20 dB

1.4 Defining Directed Advertising Event

Duty Factor for Connectable Directed Advertising Event, per advertising channel

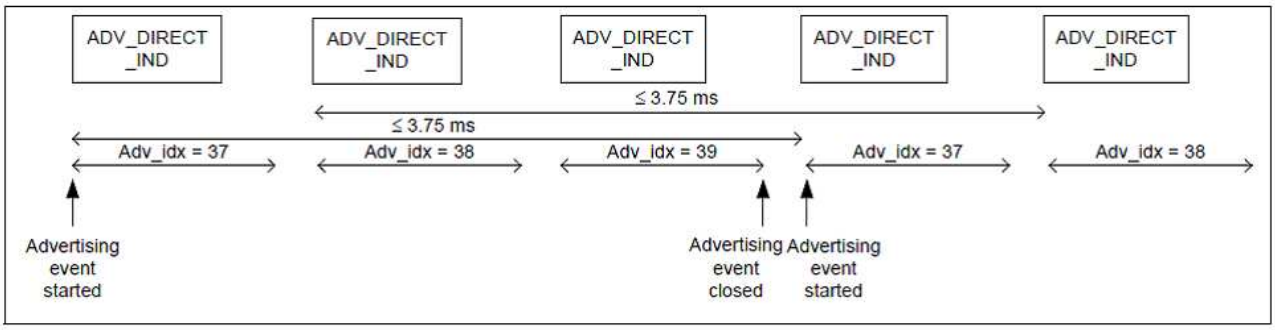


Figure D3: Connectable directed advertising event type with only advertising PDUs

1.4.1 Duty Factor for Connectable Directed Advertising Event, per advertising channel:

ADV_DIRECT_IND = 176 µS duration. (22 octets) (ON channel 37)
IFS = 150 µS (OFF)
ADV_IND = 176 µS duration (OFF channel 38)
IFS =150 µS (OFF)
ADV_IND = 176 µS duration (OFF Channel 39).
IFS=150 µS (OFF)

Time from open to close of advertising event = 3*176 + 3*150 =978 µS

1.4.1.1 Straight Duty Factor

DF = 176 / (978) = 0.179
Relaxation factor =-min (20*log10 (DF),-20 dB) =-min (-14.9,-20) = 14.9 dB

1.4.1.2 Duty Factor in 100mS window:

Number of Connectable Directed Advertising Packets, per advertising channel, per 100 mS window:
100000/978 = 102.78 packets.

Therefore, there can be 103 transmissions of packets 176 microseconds in length on one channel within a 100 mS window.
Duty Factor relative to 100 mS window: DF (rel 100 mS) = (176*103) / (100000) = 0.18128
Relaxation Factor Relative to 100 mS = - Max (20*log10 (DF (rel 100mS)),-20 dB) = -Max (-14.83 dB, -20) = 14.83 dB

END OF REPORT

Date	Version	Comments	Person
8-03-15	V0	Initial Draft Release	Adam Alger
8-11-15	V1	Final Release	Tom Smith
9-1-15	V1a	TCB Comments Addressed	Adam Alger