

# Test Report # TR 316356 A (DTS)

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**Equipment Under Test:** Sterling-LWB5

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**Test Date(s):** February 7, 2017 to May 6, 2017

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**Prepared for:**  
Laird Technologies, Inc.  
Attn: Bill Steinike  
W66N220 Commerce Court  
Cedarburg, WI 53012

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**Report Issued by:**

Signature:  Date: 5/9/2017

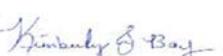
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**Report Reviewed by:** Adam Alger, Quality Systems Engineer

Signature:  Date: 5/9/2017

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**Report Constructed by:**

Signature:  Date: 5/3/2017

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Job: C-2602		Serial: WLAN-00008,00035 BLE-00009, 00015, 00019, 00032

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## Laird Technologies Test Services in Review

The Laird Technologies, Inc. laboratory located at W66 N220 Commerce Court Cedarburg, Wisconsin 53012 USA is recognized through the following organizations:



### A2LA – American Association for Laboratory Accreditation

*Accreditation based on ISO/IEC 17025: 2005 with Electrical (EMC) Scope*

*A2LA Certificate Number: 1255.01*

*Scope of accreditation includes all test methods listed herein, unless otherwise noted.*

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### Federal Communications Commission (FCC) – USA

*Accredited recognition of two 3 meter Semi-Anechoic Chambers*

*Accredited Test Firm Registration Number: 953492*

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Government  
of Canada

### Innovation, Science and Economic Development Canada

*ISED Site listing of two 3 meter Semi-Anechoic Chambers based on RSS-GEN – Issue 4*

*File Number: IC 3088A-2*

*File Number: IC 3088A-3*

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## 1 TEST REPORT SUMMARY

During **February 7, 2017-May 6, 2017** the Equipment Under Test (EUT), **Sterling-LWB5**, as provided by **Laird Technologies, Inc.** was tested to the following requirements:

FCC 15.247 / RSS-247

Requirement	Description	Specification	Method	Result
FCC: 15.247 (a)(2) ISED: RSS-247 5.2 (a)	Digital Modulation System 6 dB bandwidth	500 kHz	ANSI C63.10	Pass
FCC: 2.1049 ISED: RSS-GEN 6.6	Occupied Bandwidth	Reported	ANSI C63.10	Reported
FCC: 15.247 (b)(3) ISED: RSS-247 5.4 (d)	Maximum Conducted Output Power	30 dBm	ANSI C63.10	Pass
FCC: 15.247 (e) ISED: RSS-247 5.2 (b)	Digital Modulation System Power Spectral Density	8 dBm / 3 kHz	ANSI C63.10	Pass
FCC: 15.247 (d) ISED: RSS-247 5.5	RF Spurious Emissions at the Transmitter Antenna Terminal	20 dBc	ANSI C63.10	Pass
FCC: 15.247 (d) ISED: RSS-GEN 8.10	Spurious Radiated Emissions in Restricted Bands	FCC 15.209 RSS-GEN 8.9	ANSI C63.10	Pass
FCC: 15.207 ISED: RSS-GEN 8.8	AC Power Line Conducted Emissions	0.150-30 MHz	ANSI C63.10	Pass

### Notice:

The results relate only to the item tested and described in this report. Any modifications made to the equipment under test after the specified test date(s) may invalidate the data herein.

If the resulting measurement margin is seen to be within the uncertainty value, as listed in this report, the possibility exists that this unit may not meet the required limit specification if subsequently tested.

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## 2 CLIENT INFORMATION

<b>Company Name</b>	Laird Technologies, Inc.
<b>Contact Person</b>	Bill Steinike
<b>Address</b>	W66N220 Commerce Court, Cedarburg, WI 53012

### 2.1 Equipment Under Test (EUT) Information

*The following information has been supplied by the client*

<b>Product Name</b>	Sterling-LWB5
<b>Model Number</b>	Sterling-LWB5
<b>Serial Number</b>	WLAN – 00008, 00035 BLE – 00009, 00015, 00019, 00032
<b>FCC ID</b>	TFB-1004
<b>IC ID</b>	5969A-1004

### 2.2 Product Description

The Sterling-LWB5 is a multi-standard module with support for 2.4 GHz WLAN (802.11 b/g/n), 5.0 GHz WLAN (802.11 a/ac/n), Bluetooth V2.1+EDR, Bluetooth 3.0, and Bluetooth with multiple antenna options.

Chip Antenna: Johanson Part # 2450AD14A5500 peak gain 1.0 dBi (2.4 GHz) / 4.0 dBi (5.5 GHz)

U.FL Antenna port utilizes the following antenna options:

LSR Part #001-0009 2.4 GHz Dipole Antenna peak gain 2.0 dBi (2.4 GHz & 5.5 GHz)

LSR Part #001-0016 2.4 GHz FlexPIFA peak gain 2.5 dBi (2.4 GHz) / 3.0 dBi (5.5 GHz)

### 2.3 Modifications Incorporated for Compliance

None noted at time of test

### 2.4 Deviations and Exclusions from Test Specifications

None noted at time of test

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## 2.5 Additional Information

Module was powered at 3.3VDC using a variable DC power supply.

WLAN settings were programmed using Sterling WLAN RF Eval Tool Version 2.8.0.0. WLAN modes, data rates and frequencies used for testing: 802.11b, HT-20, 1 Mbps, 2412 MHz, 2437 MHz, 2462 MHz; 802.11g, HT-20, 6 Mbps, 2412 MHz, 2437 MHz, 2462 MHz; 802.11n, HT-20, MCS0, 2412 MHz, 2437 MHz, 2462 MHz; 802.11n, HT-40, MCS0, 2422 MHz, 2442, MHz, 2462 MHz.

BLE settings were programmed using Bluetooth RF Eval Tool Version 8.7.0.0. Frequencies used: 2402 MHz, 2440 MHz, 2480 MHz.

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### 3 REFERENCES

Publication	Edition	Date	AMD 1	AMD 2	Type
47 CFR, Parts 0-15 (FCC)		2017			
RSS 247	2	2017			
RSS GEN	4	2014			
ANSI C63.10		2013			
FCC KDB 558074 D01 v04		2017			

## 4 UNCERTAINTY SUMMARY

Using the guidance of the following publications the calculated measurement uncertainty represents an expanded uncertainty expressed at approximately the 95 % confidence level, using a coverage factor of  $k = 2$ .

References	Version / Date
CISPR 16-4-1	Ed. 2 (2009-02)
CISPR 16-4-2	Ed. 2 (2011-06)
CISPR 32	Ed. 1 (2012-01)
ANSI C63.23	2012
A2LA P103	February 4, 2016
A2LA P103c	August 10, 2015
ETSI TR 100-028	V1.3.1 (2001-03)

Measurement Type	Configuration	Uncertainty ±
Radiated Emissions	Biconical Antenna	5.0 dB
Radiated Emissions	Log Periodic Antenna	5.3 dB
Radiated Emissions	Horn Antenna	4.7 dB
AC Line Conducted Emissions	Artificial Mains Network	3.4 dB
Telecom Conducted Emissions	Asymmetric Artificial Network	4.9 dB
Disturbance Power Emissions	Absorbing Clamp	4.1 dB
Radiated Immunity	3 Volts/meter	2.2 dB
Conducted Immunity	CDN/EM/BCI	2.4/3.5/3.4 dB
EFT Burst/Surge	Peak pulse voltage	164 volts
ESD Immunity	15 kV level	1377 Volts

Parameter	ETSI U.C. ±	U.C. ±
Radio Frequency, from F0	$1 \times 10^{-7}$	$0.55 \times 10^{-7}$
Occupied Channel Bandwidth	5 %	2 %
RF conducted Power (Power Meter)	1.5 dB	1.2 dB
RF conducted emissions (Spectrum Analyzer)	3.0 dB	1.7 dB
All emissions, radiated	6.0 dB	5.3 dB
Temperature	1° C	0.65° C
Humidity	5 %	2.9 %
Supply voltages	3 %	1 %

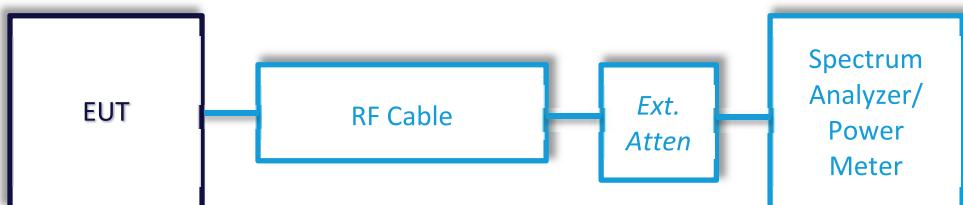
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## 5 TEST DATA

### 5.1 Antenna Port Conducted Emissions

<b>Description of Measurement</b>	<p>The direct measurement of emissions at the antenna port of the EUT is achieved by use of a RF connection to a spectrum analyzer or power meter.</p> <p>The cable and attenuator factors are loaded into the analyzer or power meter allowing for direct measurement readings without the need for further corrections.</p>
<b>Example Calculations</b>	<p>Measurement (dBm) + Cable factor (dB) + External Attenuator (dB) = Corrected Reading (dBm)</p> <p>Margin (dB) = Limit (dBm) – Corrected Reading (dBm)</p>

**Block Diagram**



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### 5.1.1 Antenna Port Conducted Emissions – Duty Cycle

<b>Operator</b>	Kimberly Bay / Shane Dock
<b>QA</b>	John Johnston / Kimberly Bay
<b>Test Date</b>	February 7, 2017 / March 1, 2017 / March 29, 2017
<b>Location</b>	Conducted RF Test Bench
<b>Temp. / R.H.</b>	21°C / 34-35% RH
<b>Method</b>	ANSI C63.10 2013 Section 11.6

#### Test Parameters

<b>Settings</b>	RBW = 8 MHz, VBW = 50 MHz, zero span
<b>EUT</b>	1 channel each: 802.11b, 802.11g, 802.11n, 802.11n HT-40, BLE
<b>Example Calculations</b>	<p><u>Duty Cycle</u> = (on-time)/(on-time + off-time)  Ex: <math>(390.5 \mu\text{s}) / (390.5 \mu\text{s} + 234.5 \mu\text{s}) = 0.625</math></p> <p><u>Duty Cycle Correction</u> = <math>10 \log(1/\text{duty cycle})</math>  Ex: <math>10 \log(1/0.625) = 2.04</math></p>

#### Instrumentation



Date :	6-Feb-2017	Type Test :	DTS Conducted RF Measurements	Job # :	C-2602			
Prepared By:	Kim/Shane	Customer:	Laird Technologies, Inc.	Quote #:	316356			
No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960087	Spectrum Analyzer	Agilent	N9010A	MY53400296	12/22/2016	12/22/2017	Active Calibration
2	AA 960143	Phaseflex	Gore	EKD01D01048.0	5546519	6/26/2015	6/25/2017	Active Calibration
3	AA 960172	Cable - low loss 1m	A.H. Systems, Inc	SAC-26G-1	387	5/16/2016	5/16/2017	Active Verification
4	EE 960085	EMI Receiver	Agilent	N9038A	MY51210148	5/12/2016	5/12/2017	Active Calibration

Table –Duty Cycles and Duty Cycle Correction Factors

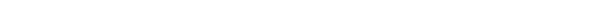
Mode	Duty Cycle	Correction Factor
802.11b	0.98	0
802.11g	0.96	0.18
802.11n	0.958	0.19
802.11n HT-40	0.93	0.315
BLE	0.625	2.04

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## Plots – Duty Cycle

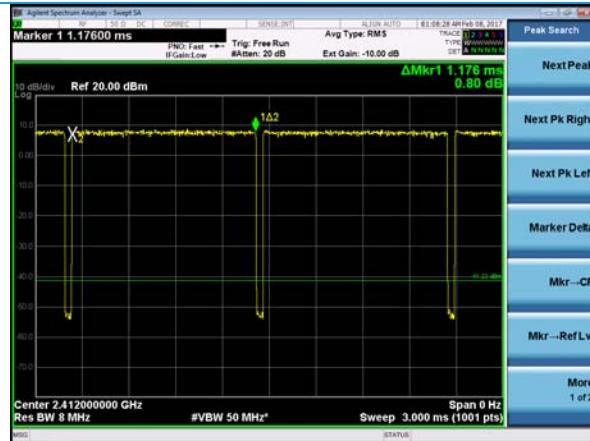


802.11b On-Time

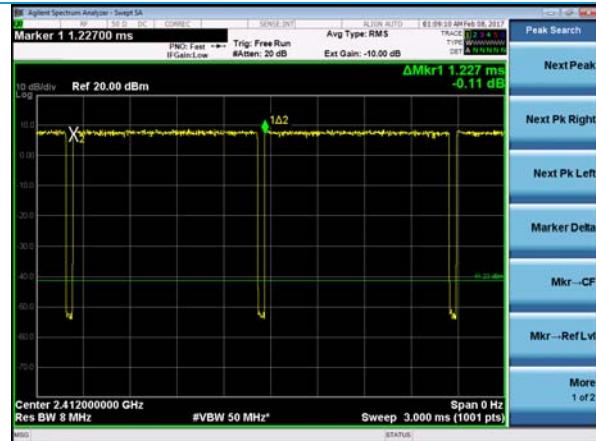


802.11g On-Time

802.11g – On + Off-Time

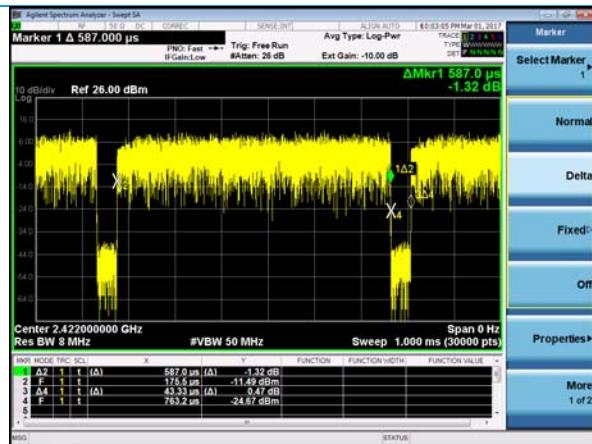


802.11n On-Time

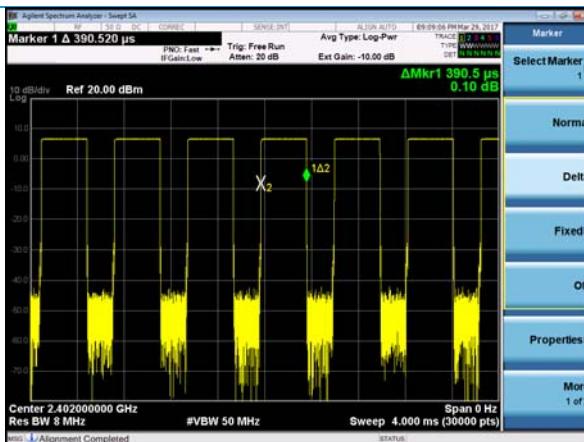


802.11n – On + Off-Time

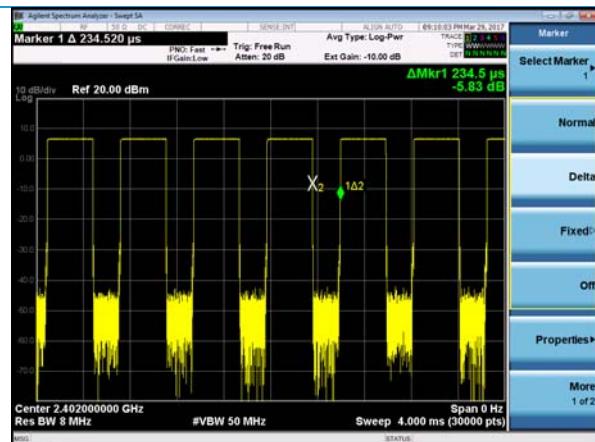
## Plots – Duty Cycle, continued



802.11n HT-40 On & Off-Times



BIF On-Time



BLE Off-Time

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### 5.1.2 Antenna Port Conducted Emissions – Bandwidth

<b>Operator</b>	Shane Dock / Kimberly Bay
<b>QA</b>	Kimberly Bay / Shane Dock
<b>Test Date</b>	February 22, 2017 / March 17, 2017 / March 29, 2017
<b>Location</b>	Conducted RF Test Bench
<b>Temp. / R.H.</b>	21-22°C / 34-35% RH
<b>Requirement</b>	6 dB BW – FCC 15.247 (a)(2) / RSS-247 Section 5.2 (a)
<b>Method</b>	6dB BW - ANSI C63.10 2013 Section 11.8.1 Option 1 OBW (99%) – ANSI C63.10 2013 Section 6.9.3

#### Limits:

##### 6 dB BW

The minimum 6 dB bandwidth shall be at least 500 kHz.

#### Test Parameters

<b>EUT</b>	<u>802.11b HT-20, 1 Mbps:</u> 2412, 2437, 2462 MHz
<b>EUT</b>	<u>802.11g HT-20, 6 Mbps:</u> 2412, 2437, 2462 MHz
<b>EUT</b>	<u>802.11n HT-20, MCS0:</u> 2412, 2437, 2462 MHz
<b>EUT</b>	<u>802.11n HT-40, MCS0:</u> 2422, 2442, 2462 MHz
<b>EUT</b>	<u>BLE:</u> 2402, 2440, 2480 MHz

#### Instrumentation



Date : 6-Feb-2017	Type Test : DTS Conducted RF Measurements	Job # : C-2602						
Prepared By : Kim/Shane	Customer : Laird Technologies, Inc.	Quote #: 316356						
<hr/>								
No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960087	Spectrum Analyzer	Agilent	N9010A	MY53400296	12/22/2016	12/22/2017	Active Calibration
2	AA 360143	Phaseflex	Gore	EKD01D001048.0	5546519	6/26/2015	6/25/2017	Active Calibration
3	AA 360172	Cable - low loss 1m	A.H. Systems, Inc	SAC-26G-1	387	5/16/2016	5/16/2017	Active Verification
4	EE 960085	EMI Receiver	Agilent	N9038A	MY51210148	5/12/2016	5/12/2017	Active Calibration

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**Table – WLAN 6 dB BW**

Channel	802.11b (MHz)	802.11g (MHz)	802.11n (MHz)	802.11n - HT40 (MHz)
Low	8.1	16.4	17.6	36.5
Mid	8.1	16.4	17.6	36.4
High	8.1	16.4	17.6	36.5

**Table – WLAN 99% BW**

Channel	802.11b (MHz)	802.11g (MHz)	802.11n (MHz)	802.11n - HT40 (MHz)
Low	11.0	17.4	18.4	36.3
Mid	11.1	17.4	18.3	36.3
High	11.3	17.5	18.4	36.3

**Table – BLE 6 dB BW**

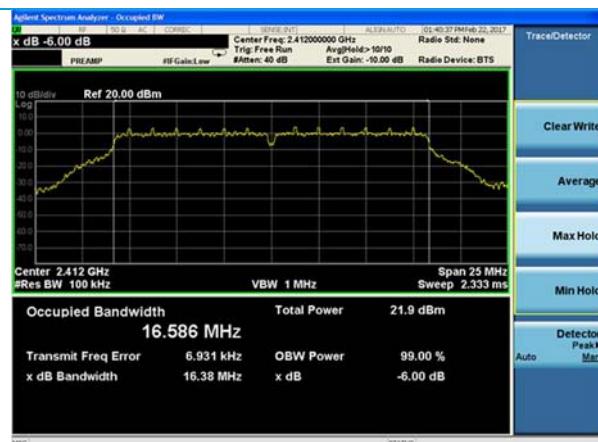
Channel	BW (MHz)
Low	0.722
Mid	0.720
High	0.718

**Table – BLE 99% BW**

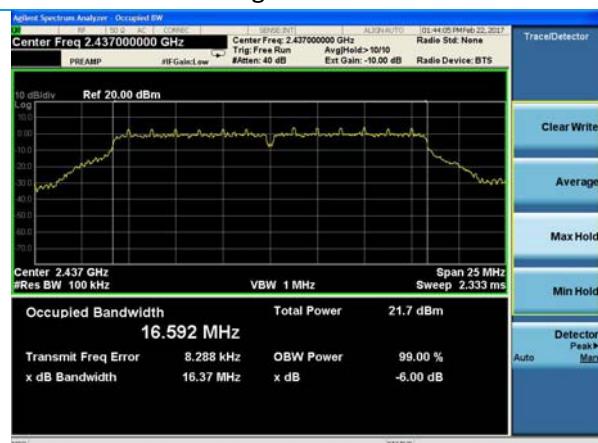
Channel	BW (MHz)
Low	1.05
Mid	1.06
High	1.05

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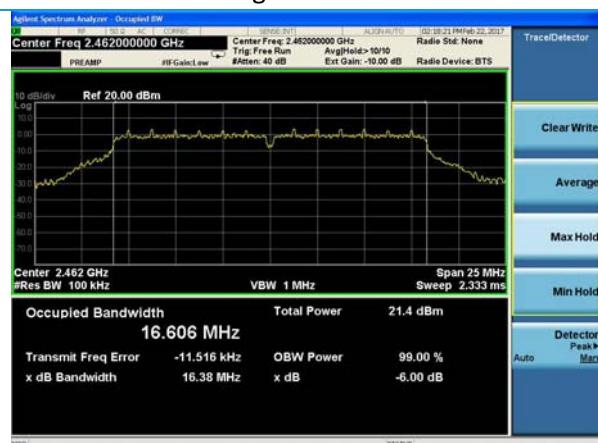
## Plots – WLAN 6 dB BW



802.11b – Low Channel



802.11b – Mid Channel



802.11b – High Channel

802.11g – Mid Channel

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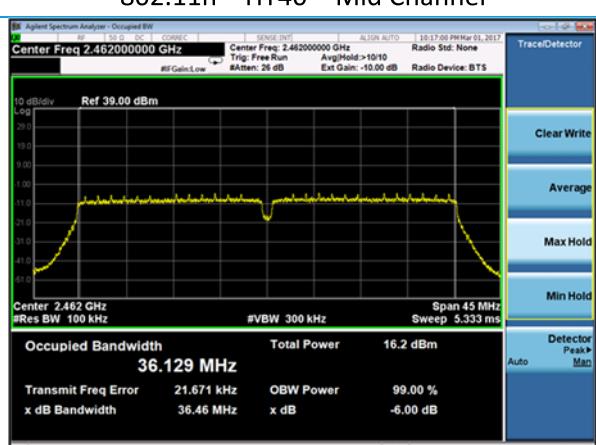
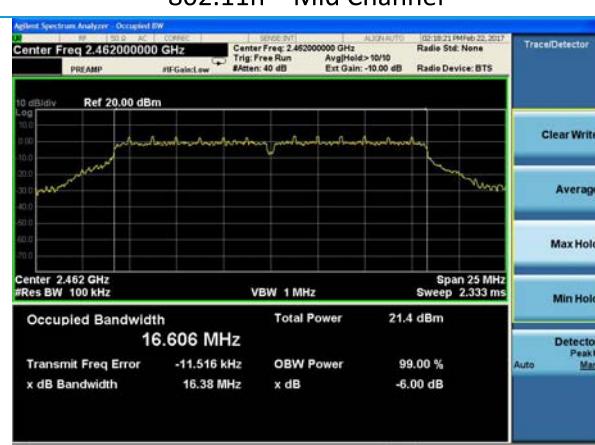
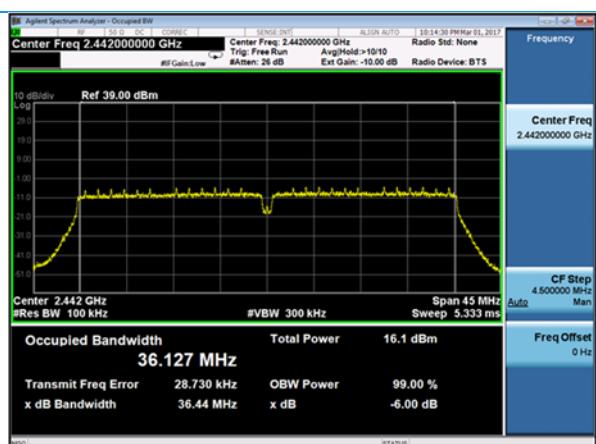
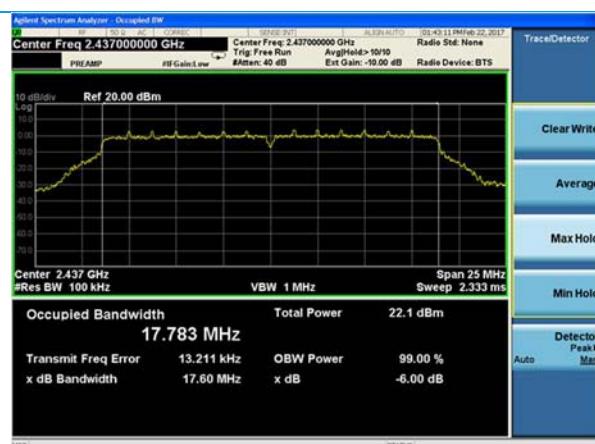
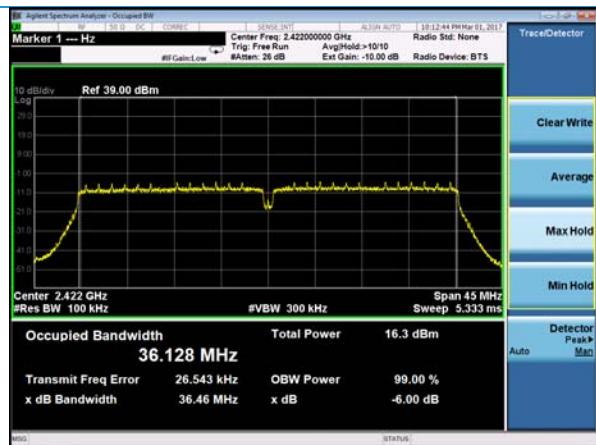
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## Plots – WLAN 6 dB BW, continued



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## Plots – WLAN 99% BW



802.11b – Low Channel



802.11b – Mid Channel



802.11b – High Channel

802.11g – High Channel

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