

## ENGINEERING TEST REPORT # TR 316356 D (DFS) LSR Job #: C-2602

Compliance Testing of:
Sterling LWB5
Test Date(s):
April 27, 2017
Prepared For:
Laird Technologies, Inc.
Attn: Bill Steinike
W66N220 Commerce Ct.
Cedarburg, WI 53012

This Test Report is issued under the Authority of:		
Signature:	Kinduly & Bay_	Date: 5/9/17

Test Report Reviewed by: Report by:

Adam Alger, Quality Systems Engineer
Signature: Date: 5/9/2017 Signature: Date: 4/27/17

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Prepared For: Laird Technologies, Inc.	Name: Sterling LWB5
Report: TR 316356 D (DFS)	Model: Sterling LWB5
Job Number: C-2602	Serial: Engineering Sample

## **Table of Contents**

i.	Title Page	. 1
ii.	Table of Contents	. 2
iii.	LS Research, LLC in Review	. 3
1.0	Summary of Test Report	. 4
2.0	Test Facilities	. 4
3.0	Client Information	. 5
3.1	Equipment Under Test (EUT) Information	. 5
3.2	Product Description	. 5
3.3	Modifications Incorporated In the EUT for Compliance Purposes	. 5
3.4	Deviations & Exclusions from Test Specifications	. 5
3.5	Additional Information	. 5
4.0	Conditions of Test.	6
5.0	Test Equipment	6
6.0	Conformance Summary	6
Apper	ndix A – Test Equipment	. 7
Apper	ndix B – Test Data	8
B.1	– DFS	8
Inforn	nation as required by KDB 905462 D02 Section 8:	14
Apper	ndix C - References	17

Prepared For: Laird Technologies, Inc.	Name: Sterling LWB5
Report: TR 316356 D (DFS)	Model: Sterling LWB5
Job Number: C-2602	Serial: Engineering Sample

#### **Laird Technologies Test Services in Review**

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



#### A2LA – American Association for Laboratory Accreditation

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

A2LA Certificate Number: 1255.01

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



#### Federal Communications Commission (FCC) - USA

Accredited recognition of two 3 meter Semi-Anechoic chambers Accredited Test Firm Registration Number: 953492



# Government of Canada

#### Innovation, Science and Economics 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

Prepared For: Laird Technologies, Inc.	Name: Sterling LWB5
Report: TR 316356 D (DFS)	Model: Sterling LWB5
Job Number: C-2602	Serial: Engineering Sample

## 1.0 Summary of Test Report

On April 27<sup>th</sup> 2017 the EUT, Sterling LWB5, as supplied by Laird Technologies, Inc. was tested and was found to MEET the following requirements:

Operation in the 5.25 – 5.35 GHz and 5.47 – 5.725 GHz bands

]	FCC Rule Part	IC Standard	Test Description	Measurement Procedure	Test Result
	15.407 (h)(2)	RSS-247 Section 6.3	Dynamic Frequency Selection	FCC KDB 905462 D02	Pass*
	15.407 (h)(2)(ii)	RSS-247 Section 6.3	Channel Availability Check Time	FCC KDB 905462 D02	N/A*
	15.407 (h)(2)(iii)	RSS-247 Section 6.3	Channel Move Time	FCC KDB 905462 D02	Pass
	15.407 (h)(2)(iv)	RSS-247 Section 6.3	Non-Occupancy period	FCC KDB 905462 D02	Pass

<sup>\*</sup> The EUT is a client only device

#### 2.0 Test Facilities

All testing was performed at:

Laird Technologies Test Services W66 N220 Commerce Court Cedarburg, Wisconsin, 53012 USA

Prepared For: Laird Technologies, Inc.	Name: Sterling LWB5
Report: TR 316356 D (DFS)	Model: Sterling LWB5
Job Number: C-2602	Serial: Engineering Sample

#### 3.0 Client Information

Manufacturer Name: Laird Technologies, Inc.	
Address:	W66N220 Commerce Ct.
Audress:	Cedarburg, WI 53012
<b>Contact Person:</b>	Bill Steinike

#### 3.1 Equipment Under Test (EUT) Information

The following information has been supplied by the applicant.

<b>Product Name:</b>	Sterling-LWB5 Module
<b>Model Number:</b>	Sterling-LWB5
Serial Number:	Engineering sample

#### 3.2 Product Description

The Sterling-LWB5 is a multi-standard module with support for WLAN (802.11 a/b/g/n/ac), Bluetooth 2.1+EDR, Bluetooth 3.0, and Bluetooth 4.1 (Bluetooth Low Energy) 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)

### 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

During testing, EUT was paired up with a CISCO AIR-AP2802E-B-K9 (MAC: 0081C46C96E6), FCC ID: LDK102099, IC ID: 2461B-102099, and SN: FJC2052M291. Data streaming between the EUT (client) and AP was achieved using 'iperf'. The link established used a communication bandwidth of 80MHz with a center frequency at 5530MHz.

Prepared For: Laird Technologies, Inc.	Name: Sterling LWB5
Report: TR 316356 D (DFS)	Model: Sterling LWB5
Job Number: C-2602	Serial: Engineering Sample

#### 4.0 Conditions of Test

Environmental:

Temperature: 20-25° 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 Subpart E Part and RSS-247 DFS requirements.

#### 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.

Laird Technologies, Inc. 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.

	Prepared For: Laird Technologies, Inc.	Name: Sterling LWB5
ĺ	Report: TR 316356 D (DFS)	Model: Sterling LWB5
	Job Number: C-2602	Serial: Engineering Sample

## Appendix A – Test Equipment



Date : 6-Feb-2017	Type Test : 5 GHz WLAN DFS	Job # : <u>C-2602</u>
Prepared By: Aidi	Customer: LSR	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	CC 000314C	Vector Signal Generator	Agilent	E4438C	US 41469143	4/29/2015	4/28/2017	Active Calibration
3	CC 000710C	Oscilloscope	Agilent	MSO8104A	MY45001068	11/22/2016	11/22/2017	Active Calibration
4	CC 000259C	Function / Arbitrary Waveform Generator	Agilent	33250A	US40000583	11/21/2016	11/21/2017	Active Calibration

Project Engineer. Humanily & Bay \_\_\_ Quality Assurance: Adum O Afre

Prepared For: Laird Technologies, Inc.	Name: Sterling LWB5
Report: TR 316356 D (DFS)	Model: Sterling LWB5
Job Number: C-2602	Serial: Engineering Sample

## Appendix B – Test Data B.1 – DFS

Manufacturer	Laird Technologies, Inc.	
Test Location	tion Laird Technologies Test Services	
Rule Part	FCC Subpart E IC RSS-247	
General Measurement Procedure	Client without Radar Detection Requirements Prior to Use of a Channel  1. Non-Occupancy Period minimum 30 minutes  Client without Radar Detection Requirements During Normal Operation  1. Channel Closing Time 200 ms + an aggregate of 60 ms over remaining 10 second period using Radar Type 0 starting at beginning of Channel move time plus any additional control signals not counting quiet periods during the remaining 10 second period.  2. Channel Move Time 10 seconds using Radar Type 0  Pulse width = 1 μsec PRI = 1428 μsec Number of Pulses = 18	
General Description of Measurement	Conducted Setup for Client with injection at the Master (Section 7.2.2) (see setup photo exhibit)  Radar Test Signal Generator = Arbitrary Waveform Generator + Signal Generator with Ext pulse input  EUT Setup to connect to CISCO AIR-AP28025-B-K9 AP and perform data streaming using 'I-Perf'. The streaming link was over an 802.11ac 80MHz channel on 5530MHz. Channel loading was shown to be greater than 17%.	

Prepared For: Laird Technologies, Inc.	Name: Sterling LWB5
Report: TR 316356 D (DFS)	Model: Sterling LWB5
Job Number: C-2602	Serial: Engineering Sample

## 7.2.2 Setup for Client with injection at the Master

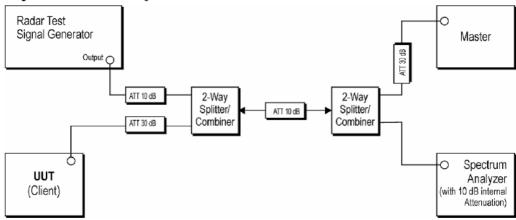
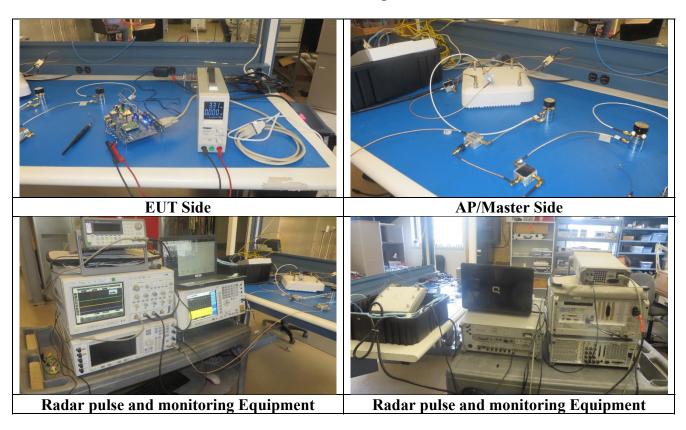


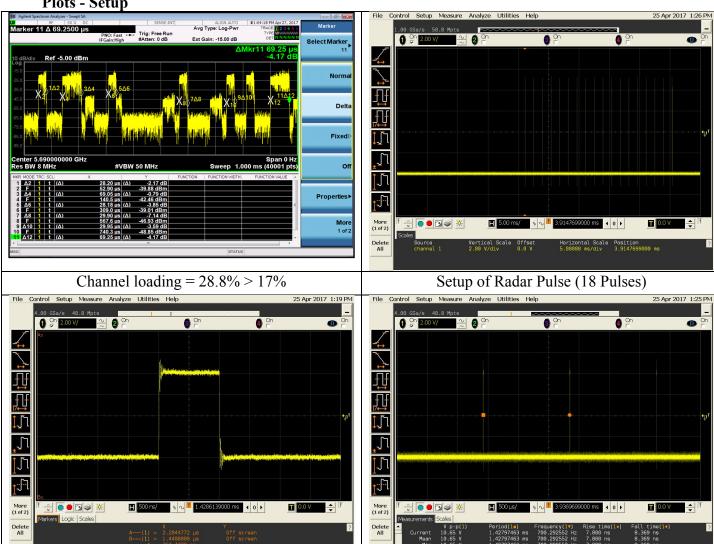
Figure 3: Example Conducted Setup where UUT is a Client and Radar Test Waveforms are injected into the Master

## **EUT Test Setup**



Prepared For: Laird Technologies, Inc.	Name: Sterling LWB5
Report: TR 316356 D (DFS)	Model: Sterling LWB5
Job Number: C-2602	Serial: Engineering Sample



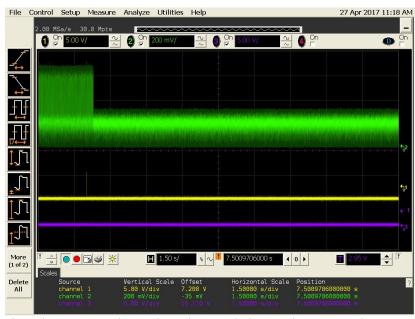


Setup of Rac	lar Pulse (Pu	llse Width 1 us)

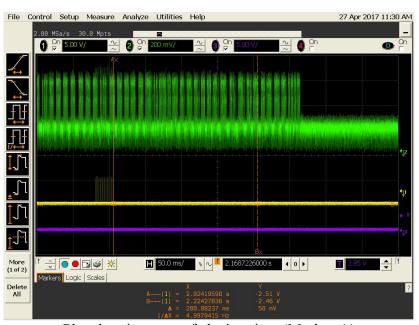
Setup of Radar Pulse (PRI 1.428 ms)

	Prepared For: Laird Technologies, Inc.	Name: Sterling LWB5
Ī	Report: TR 316356 D (DFS)	Model: Sterling LWB5
	Job Number: C-2602	Serial: Engineering Sample
-		

## Plots - Performing the test

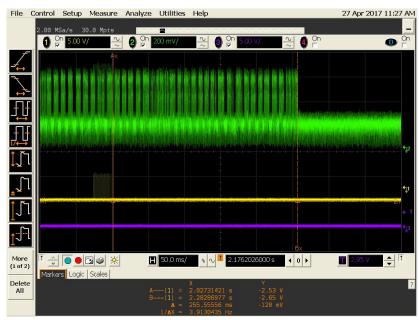


Radar pulse introduced at 2 seconds mark and extends beyond 10 seconds. Note the radar pulse in the yellow trace.

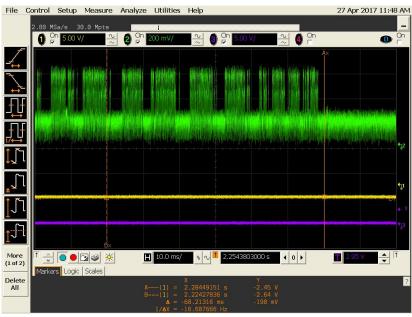


Plot showing start of closing time (Marker A)

Report: TR 316356 D (DFS)	Model: Sterling LWB5
Job Number: C-2602	Serial: Engineering Sample



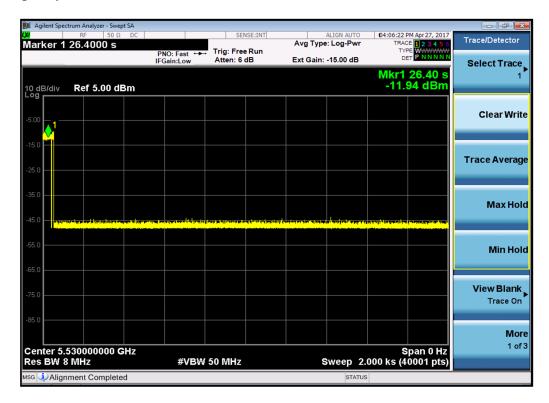
Plot showing that all forms of transmissions are concluded in 255ms



Plot showing that transmissions after the first 200ms is less than 60ms. Refer to the delta between marker A and B.

Report: TR 316356 D (DFS)	Model: Sterling LWB5
Job Number: C-2602	Serial: Engineering Sample

## **Non-Occupancy Period**



Plot above shows that there are no transmissions on the channel for more than 30 minutes after radar had been detected.

Prepared For: Laird Technologies, Inc.	Name: Sterling LWB5
Report: TR 316356 D (DFS)	Model: Sterling LWB5
Job Number: C-2602	Serial: Engineering Sample

## Information as required by KDB 905462 D02 Section 8:

## Section 8.1:

8.1 Complete description of the U-NII device		
a) The operating frequency range(s) of the equipment.	5260MHz - 5320MHz, 5500MHz-5700MHz	
b) The operating modes (Master and/or Client) of the U-NII device. Bridge modes and MESH modes, as applicable, must be included in the description.	Client with no radar detection capability	
c) For Client devices, indicate whether or not it has radar detection capability and indicate the FCC identifier for the Master U-NII Device that is used with it for DFS testing.	Client with no radar detection capability. Master used with testing, FCCID LDK102099.	
d) List the highest and the lowest possible power level (equivalent isotropic radiated power (EIRP)) of the equipment.	Highest EIRP = 13.8dBm + 4.0dBi = 17.8dBm Lowest EIRP = 7.7dBm + 4.0dBi = 11.7dBm	
e) List all antenna assemblies and their corresponding gains.	Refer to section 3.2 of this report	
1) If radiated tests are to be performed, the U-NII Device should be tested with the lowest gain antenna assembly (regardless of antenna type). The report should indicate which antenna assembly was used for the tests. For devices with adjustable output power, list the output power range and the maximum EIRP for each antenna assembly.	Not Applicable	
2) If conducted tests are to be performed, indicate which antenna port/connection was used for the tests and the antenna assembly gain that was used to set the DFS Detection Threshold level during calibration of the test setup.	Not Applicable- EUT Client only	
i) Indicate the calibrated conducted DFS Detection Threshold level.	Not Applicable- EUT Client only	
ii) For devices with adjustable output power, list the output power range and the maximum EIRP for each antenna assembly.	No adjustable power. Maximum EIRP = 17.8dBm	
iii) Indicate the antenna connector impedance. Ensure that the measurement instruments match (usually 50 Ohms) or use a minimum loss pad and take into account the conversion loss.	50 ohms	
3) Antenna gain measurement verification for tested antenna.	Not Applicable- EUT Client only	
i) Describe procedure	Not Applicable- EUT Client only	
ii) Describe the antenna configuration and how it is mounted	Not Applicable- EUT Client only	
iii) If an antenna cable is supplied with the device, cable loss needs to be taken into account. Indicate the maximum cable length and either measure the gain with this cable or adjust the measured gain accordingly. State the cable loss.	Antenna cable was accounted in te gain measurement.	
f) Test sequences or messages that should be used for communication between Master and Client Devices, which are used for Channel load	EUT and Master running 'Iperf' to stream data	
1) Stream the test file from the Master Device to the Client Device for IP based systems or frame based systems which dynamically allocate the talk/listen ratio.	EUT and Master running 'lperf' to stream data	
2) For frame based systems with fixed talk/listen ratio, set the ratio to the worst case (maximum) that is user configurable during this test as specified by the manufacturer and stream the test file from the Master to the Client.	Not applicable	
3) For other system architectures, supply appropriate Channel loading methodology.	Not applicable	
g) Transmit Power Control description—Provide a description.	Not Applicable	
h) System architectures, data rates, U-NII Channel bandwidths — Indicate the type(s) of system architecture (e.g. IP based or Frame based) that the U-NII device employs. Each type of unique architecture must be tested.	Channel bandwidths: 20MHz, 40MHz and 80MHz. Data rates: 6MBPS - MCS9	
i) The time required for the Master Device and/or Client Device to complete its power-on cycle.	Client device takes less than 10 seconds to boot up	
j) Manufacturer statement confirming that information regarding the parameters of the detected Radar Waveforms is not available to the end user.	See Software security exhibit	
k) The manufacturer is permitted to select the first channel either manually or randomly. The manufacturer may also block DFS channels from use.	Not applicable-EUT client device only	

Report: TR 316356 D (DFS)  Model: Sterling LWB5	Prepared For: Laird Technologies, Inc.	Name: Sterling LWB5
Lab Namebour C 2002	Report: TR 316356 D (DFS)	Model: Sterling LWB5
Job Number: C-2602 Serial: Engineering Sample		

## Section 8.2

8.2 Complete description of the Radar Waveform calibration		
a) Description of calibration setup—Block diagram of equipment setup, clearly identifying if a radiated or conducted method was used.	Not Applicable- EUT client device only	
b) Description of calibration procedure	Not Applicable- EUT client device only	
1) Verify DFS Detection Threshold levels	Not Applicable- EUT client device only	
i) Indicate DFS Detection Threshold levels used.	Not Applicable- EUT client device only	
ii) Consider output power range and antenna gain.	Not Applicable- EUT client device only	
2) For the Short Pulse Radar Types, spectrum analyzer plots of the burst of pulses on the Channel frequency should be provided.	Supplied in this report	
3) For the Long Pulse Radar Type, spectrum analyzer plot of a single burst (1-3 pulses) on the Channel frequency should be provided.	Not Applicable- EUT client device only	
4) Describe method used to generate frequency hopping signal.	Not Applicable- EUT client device only	
5) The U-NII Detection Bandwidth	Not Applicable- EUT client device only	
6) For the Frequency Hopping waveform, a spectrum analyzer plot showing 9 pulses on one frequency within the U-NII Detection Bandwidth should be provided.	Not Applicable- EUT client device only	
7) Verify use of vertical polarization for testing when using a radiated test method.	Not applicable- testing performed conducted	
c) When testing a Client Device with radar detection capability, verify that the Client Device is responding independently based on the Client Device's self-detection rather than responding to the Master Device. If required, provide a description of the method used to isolate the client from the transmissions from the Master Device to ensure Client Device self-detection of the Radar Waveform.	Not Applicable- EUT client device only without radar detection capability	

Prepared For: Laird Technologies, Inc.	Name: Sterling LWB5
Report: TR 316356 D (DFS)	Model: Sterling LWB5
Job Number: C-2602	Serial: Engineering Sample

## Section 8.2

Description of deviations to the procedures or equipment described in this document.  Description of DFS test procedure and test setup used to monitor the U-Nil device and Radar Waveform transmissions. Provide a block diagram of the signal monitoring equipment setup.  Jist of equipment  Size Agencials of this report.  See Agencials for this report.  See Agencials for this report.  Jist of equipment setup.  Jist of equipment setup.  See Agencials for this report.  Jist of equipment setup.  See Agencials for this report.  See Agencials for this report.  See Agencials for this report.  Jist of the waveforms that were used for each signal type, supply the characteristics (pulse width, pulse repetition interval, number of pulses per burst, modulation).  Por selecting the waveform parameters from within the bounds of the signal type, describe how they were selected (i.e., manually or randomly).  See Agencials for this report.  Advantagly using arbitrary waveform generator and signal generator of Channel loading description including data type, timing plots, percentage of channel loading calculation, and protocol.  Jist seeds Channel frequency that was used for the tests.  Jist seed Channel frequency that was used for the tests.  Jist seed Channel frequency that was used for the tests.  Jist seeds the service of the service of the tests.  Jist seeds that the service of the se		
Discription of DFS test procedure and test setup used to monitor the U-NII device and Radar Waveform transmissions. Provide a block diagram of the signal monitoring equipment setup.    District designment	8.3 Complete description of test procedure	
equipment stup.  If yet setup photos  See Appendix a of this report  I best setup photos  See Appendix a of this report  I best setup photos  See Appendix a of this report  See Appendix and this report  See Appendix and the second of this report  S	a) Description of deviations to the procedures or equipment described in this document.	No deviations during test
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See Appendix 8 of this report  3 Book diagram of equipment setup  3 Book diagram of equipment setup  3 Rest setup photos  5 Res Appendix 8 of this report  8 Res Appendix 8 of this report  8 Res Appendix 8 of this report  8 Red Type 0 In RD8035452 DO2  8 Red Type 0 In RD8035452 DO2  9 For selecting the waveform parameters from within the bounds of the signal type, describe how they were selected (i.e., manually or randomly).  9 For selecting the waveform parameters from within the bounds of the signal type, describe how they were selected (i.e., manually or randomly).  9 For selecting the waveform parameters from within the bounds of the signal type, describe how they were selected (i.e., manually or randomly).  9 Channel loading description including data type, timing plots, percentage of channel loading calculation, and protocol.  9 Plots supplied See appendix 8 of this report  10 The DFS tests are to be performed on U-NII Channel(s). Refer to Table 2 for additional requirements for devices with multiple bandwidth modes.  10 Ust each Channel frequency that was used for the tests.  10 Plot of Rif measurement system showing its nominal noise floor in the same bandwidth which is used to perform the Channel Availability Check, initial radar burst, in-  10 Secondary and the secondary secondary of the Secondary s	1) List of equipment	See Appendix A of this report
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3) Test setup photos 4) For each of the waveforms that were used for each signal type, supply the characteristics (pulse width, pulse repetition interval, number of pulses per burst, madartype of in KBB0504562 D02.  Adartype of in KBD0504562 D02.  Adartype of in KBD0504562 D02.  Adarty	1) Block diagram of equipment setup	See Appendix B of this report
4) For each of the waveforms that were used for each signal type, supply the characteristics (pulse width, pulse repetition interval, number of pulses per burst, modulation).  Radad type 0 in KD8905462 D02 doubted in the pulse per burst, and the pulse per burst, modulation).  Manually using arbitrary waveform generator and signal generator of the pulse per burst, and t	2) List of equipment	See Appendix A of this report
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limit found in Table 4.  2) Indicate the total number of times the test was performed.  3) Indicate a detect/not detect for each waveform within a signal type and the number of failures and the number of successful radar detection times within the time limit.  Sample data sheets are shown in Tables 8-11.  4) Verify compliance with the minimum percentage of successful detection requirements found in Tables 5-7.  Not Applicable-EUT client device of the successful detection requirements found in Tables 5-7.	Monitoring. The plots need to show U-NII device transmissions on the Channel in the form of RF activity on the vertical axis versus time on the horizontal axis. Only one 10 second plot needs to be reported for Radar Type 0. The plot for the Short Pulse Radar Types should start at the end of the radar burst. The Channel Move Time will be calculated based on the plot of Radar Type 0. The plots need to show U-NII device transmissions on the Channel in the form of RF activity on the vertical axis versus time on the horizontal axis. Sufficient resolution should be used.	
3) Indicate a detect/not detect for each waveform within a signal type and the number of failures and the number of successful radar detection times within the time limit.  Sample data sheets are shown in Tables 8-11.  4) Verify compliance with the minimum percentage of successful detection requirements found in Tables 5-7.  Not Applicable-EUT client device of the same of the		Provided in Appendix B
Sample data sheets are shown in Tables 8-11.  Not Applicable-EUT client device of the More Applicable and the More Applicable	2) Indicate the total number of times the test was performed.	Not Applicable-EUT client device only
		Not Applicable-EUT client device only
	4) Verify compliance with the minimum percentage of successful detection requirements found in Tables 5-7.	Not Applicable-EUT client device only
i) Spectrum Analyzer plot(s) showing compliance with the 30 minute Non-Occupancy Period requirement. Only one plot is required. This is a separate test that is performed in addition to the other In-Service Monitoring tests.		Provided in Appendix B

Prepared For: Laird Technologies, Inc.	Name: Sterling LWB5
Report: TR 316356 D (DFS)	Model: Sterling LWB5
Job Number: C-2602	Serial: Engineering Sample

## **Appendix C - References**

Publication	Year	Title
FCC CFR Parts 0-15	2017	Code of Federal Regulations – Telecommunications
RSS-247 Issue 2	2017	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
FCC KDB 905462 D02 v02	2016	UNII DFS Compliance Procedures New Rules v01r02

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## **END OF REPORT**

Date	Version	Comments	Person
4/28/17	V0	Initial Draft Release	KB
5/9/17	V1	Final	KB

Prepared For: Laird Technologies, Inc.	Name: Sterling LWB5
Report: TR 316356 D (DFS)	Model: Sterling LWB5
Job Number: C-2602	Serial: Engineering Sample