

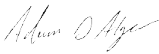
Test Report # 317050

Equipment Under Test: Sterling-LWB

Test Date(s): February 9-11, April 28, May 25, June 8, 2017

Prepared for: Laird
Attn: Bill Steinike
W66 N220 Commerce Ct.
Cedarburg, WI 53012

Report Issued by: Adam Alger, Quality Systems Engineer

Signature: 

Date: June 12, 2017

Report Reviewed by: Ryan Urness, Director of Test Services

Signature: 

Date: June 11, 2017

Report Constructed by: Adam Alger, Quality Systems Engineer

Signature: 

Date: June 9, 2017

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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.



Federal Communications Commission (FCC) – USA

Accredited recognition of two 3 meter Semi-Anechoic Chambers

Accredited Test Firm Registration Number: 953492



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

Company: Laird	Page 3 of 28	Name: Sterling-LWB
Report: TR 317050		Model: Sterling-LWB
Job: C-2678		Serial: See Section 2.1

1 TEST REPORT SUMMARY

On **February 9-11, April 28, May 25, and June 8, 2017**, the Equipment Under Test (EUT), **Sterling-LWB**, as provided by **Laird** was tested to the following requirements:

ETSI EN 300 328 V2.1.1

Requirement	Description	Specification	Method	Compliant
4.3.1.12	Receiver Blocking - FHSS (Bluetooth)	Manufacture Declared*	5.4.11	Yes
4.3.2.11	Receiver Blocking - Wide Band Modulation (BLE)	Manufacture Declared*	5.4.11	Yes
4.3.2.11	Receiver Blocking - Wide Band Modulation (WLAN)	≤ 10 %	5.4.11	Yes

Draft ETSI EN 301 489-17 V3.2.0 referencing Draft ETSI EN 301 489-1 V2.2.0

Method	Phenomenon	Application	Specification	Compliant
EN 61000-4-3	Radiated RF Immunity	Enclosure	1 - 6 GHz: 3 V/m	Yes

*See test data for details

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.

2 CLIENT INFORMATION

Company Name	Laird
Contact Person	Bill Steinike
Address	W66 N220 Commerce Ct. Cedarburg, WI 53012

2.1 Equipment Under Test (EUT) Information

The following information has been supplied by the client

Product Name	Sterling-LWB
Model Number	Sterling-LWB
Serial Number	13, 16, 26

2.2 Product Description

The Sterling-LWB is a multi-standard module with support for WLAN (802.11 b/g/n), and Bluetooth V2.1 and Bluetooth 4.0 & 4.1 with multiple antenna options.

This device has been designed to operate with the antenna listed below, and having a maximum gain of 2.0 dBi. The required antenna impedance is 50 ohms.

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

2.5 Performance Criteria (Immunity)

Minimum Performance level specified by manufacturer:

No resets or drop in communication during test

3 REFERENCES

Publication	Edition	Date
ETSI EN 300 328	V2.1.1	2016-11
ETSI EN 301 489-17	V3.2.0 Draft	2017-03
ETSI EN 301 489-1	V2.2.0 Draft	2017-03

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 $\pm$
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. $\pm$	U.C. $\pm$
Radio Frequency, from F0	1×10^{-7}	0.55×10^{-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 %

5 TEST DATA

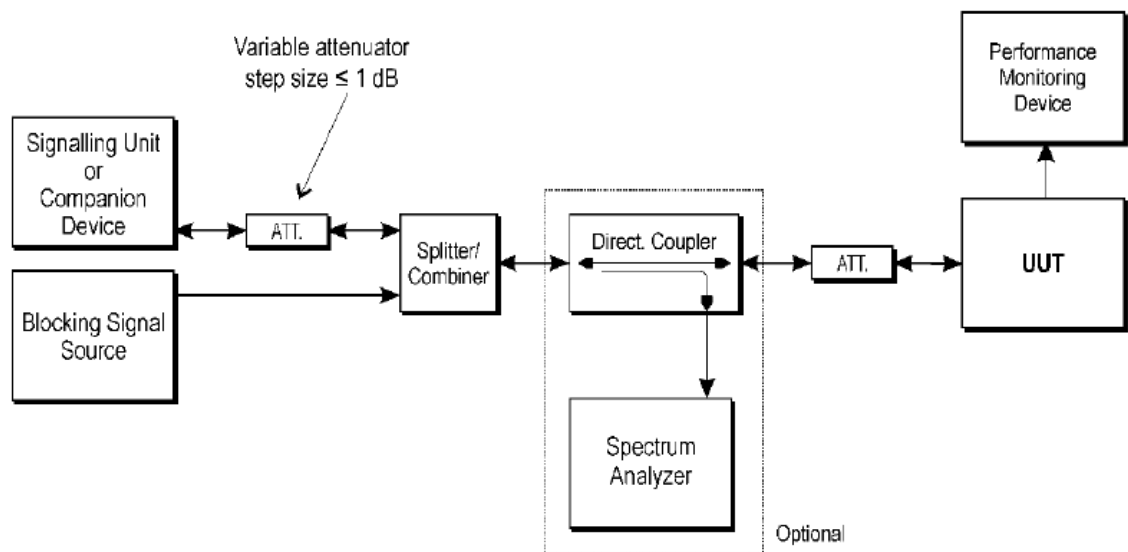
5.1 Antenna Port Conducted Emissions – Receiver Blocking BT

Operator	Aidi Zainal
QA	Adam Alger
Test Date	4/28/2017
Location	Screen room
Temp. / R.H.	20-25° C / 30-50 % R.H.
Requirement	ETSI EN 300 328 V2.1.1 Section 4.3.1.12
Method	ETSI EN 300 328 V2.1.1 Section 5.4.11

Receiver Blocking parameters receiver category 1 equipment

Wanted signal mean power from companion device (dBm)	Blocking signal frequency (MHz)	Blocking signal power (dBm) (see note 2)	Type of blocking signal
$P_{min} + 6 \text{ dB}$	2 380 2 503,5	-53	CW
$P_{min} + 6 \text{ dB}$	2 300 2 330 2 360	-47	CW
$P_{min} + 6 \text{ dB}$	2 523,5 2 553,5 2 583,5 2 613,5 2 643,5 2 673,5	-47	CW
NOTE 1: P_{min} is the minimum level of wanted signal (in dBm) required to meet the minimum performance criteria as defined in clause 4.3.1.12.3 in the absence of any blocking signal. NOTE 2: The levels specified are levels in front of the UUT antenna. In case of conducted measurements, the levels have to be corrected by the actual antenna assembly gain.			

Block Diagram



Instrumentation



No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960073	Spectrum Analyzer	Agilent	E4446A	US45300564	11/21/2016	11/21/2017	Active Calibration
2	CC 000284C	Signal Generator	Agilent	E4421B	MY41000402	11/17/2016	11/17/2017	Active Verification
3	EE 960093	Splitter/Combiner	mini-circuits	ZFSC-2-10G	SF702900616	2/27/2017	2/27/2018	Active Verification

Test Parameters

Mode	BT Hopping 1 MBPS (BR) DH1
Rx Category	1
Minimum Performance	0.1% BER
EUT	Serial 13
Companion / Monitoring Device	R&S CBT BT Tester

Setup Parameters

Frequency (MHz)	CBT level/Pmin (dBm)	Pmin + 6DB (dBm)	Path loss (dB)	CBT signal to EUT (dBm)	BER at CBT/Pmin (%)
Hopping	-70	-64	-20	-84	0.11077

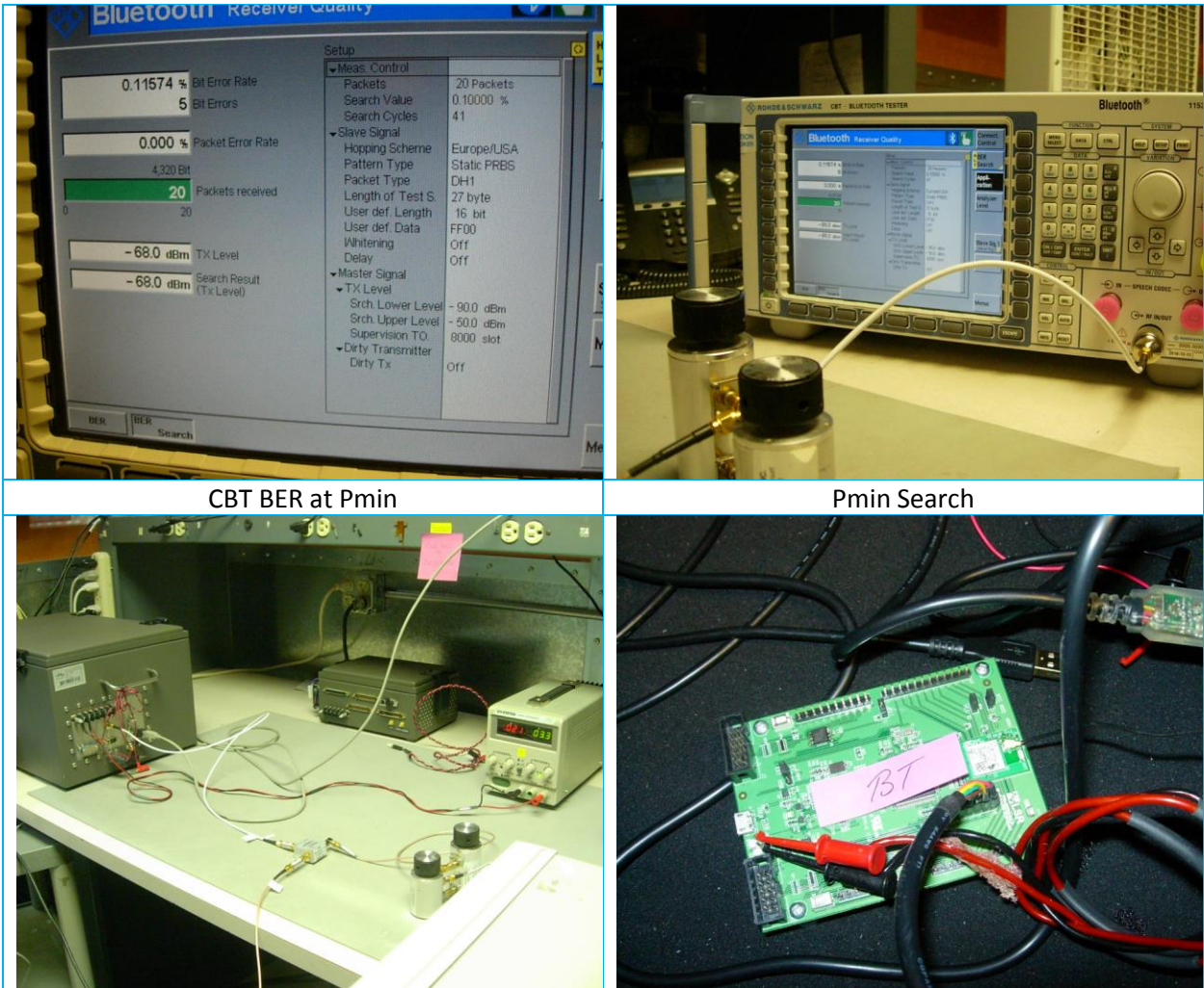
Frequency (MHz)	Level	Ant Gain	Blocking level	Sig gen setting (dBm)
2380.0	-53.0	4.3	-51.0	-24.4
2503.5	-53.0	4.3	-51.0	-24.4
2300.0	-47.0	4.3	-45.0	-18.8
2330.0	-47.0	4.3	-45.0	-18.4
2360.0	-47.0	4.3	-45.0	-18.3
2523.5	-47.0	4.3	-45.0	-18.3
2553.5	-47.0	4.3	-45.0	-18.8
2583.5	-47.0	4.3	-45.0	-18.2
2613.5	-47.0	4.3	-45.0	-17.9
2643.5	-47.0	4.3	-45.0	-18.1
2673.5	-47.0	4.3	-45.0	-18.4

Results

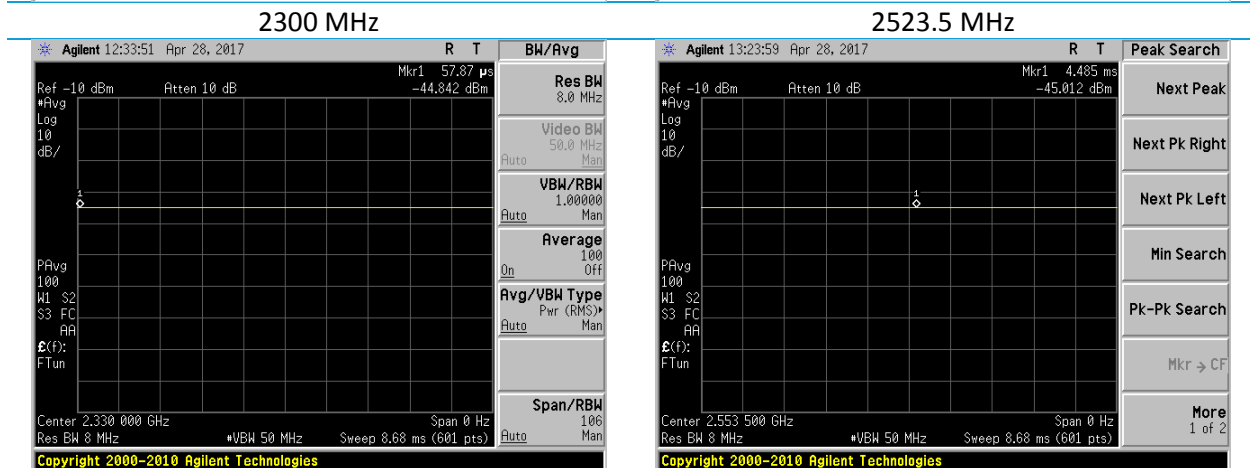
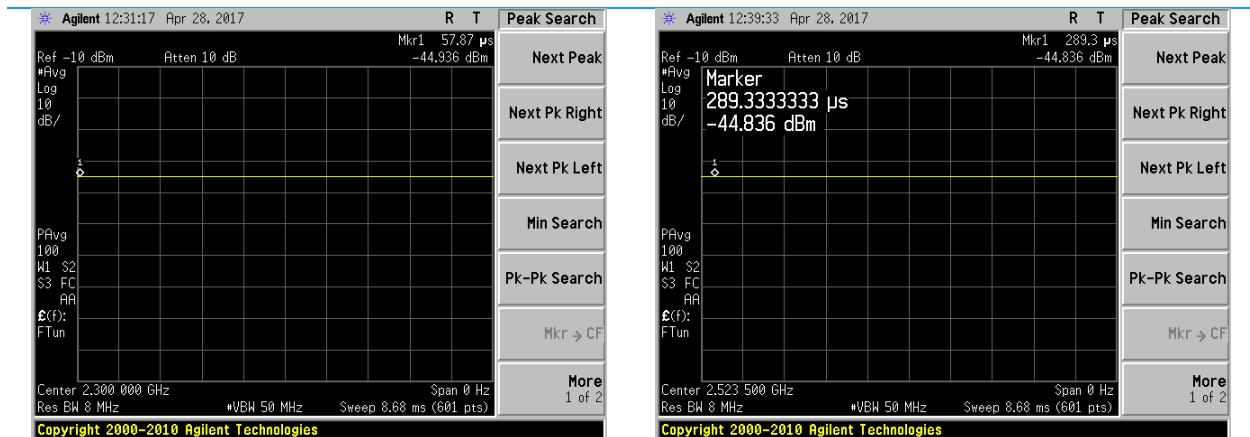
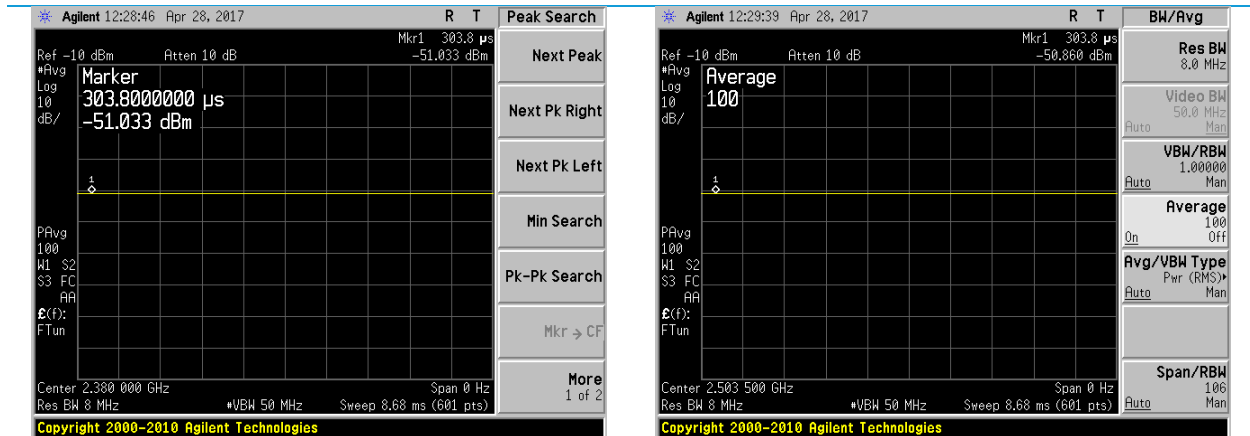
Technology /Mode	Data rate	Packet type	Result at Blocking frequencies listed (% BER)										
			2380	2503.5	2300	2330	2360	2523.5	2553.5	2583.5	2613.5	2643.5	2673.5
BT/Hopping	1MBPS	DH1	0.000	0.000	0.000	0.002	0.000	0.002	0.000	0.000	0.002	0.001	0.001

- Notes:
1. CBT sending 8200 Packets which is approximately 1.8 million bits. BER test performed 3 times at each blocking frequency.
 2. Variable attenuator set at 3dB. 10dB attenuator in path of EUT. 10dB attenuator in path of Blocking signal
 3. Pmin is companion/CBT level where the EUT has a BER at or worse than manufacturer declared minimum performance.

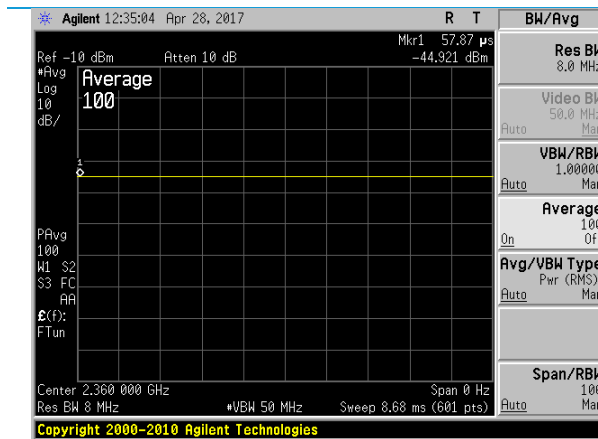
Setup Photos



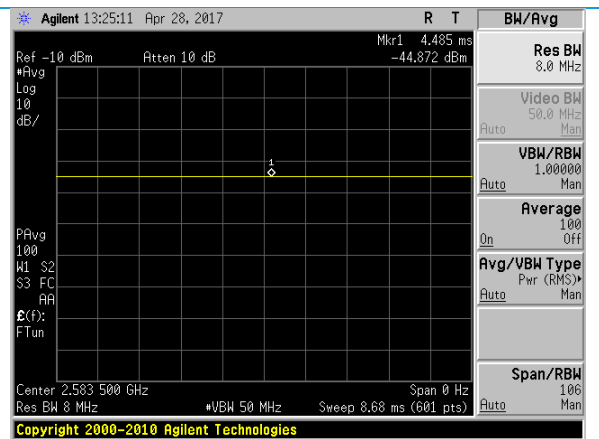
Blocking Level at input of EUT (BT Classic)



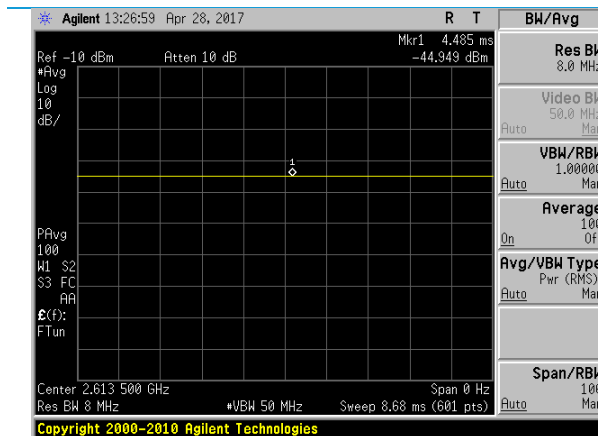
Blocking Level at input of EUT (BT Classic)



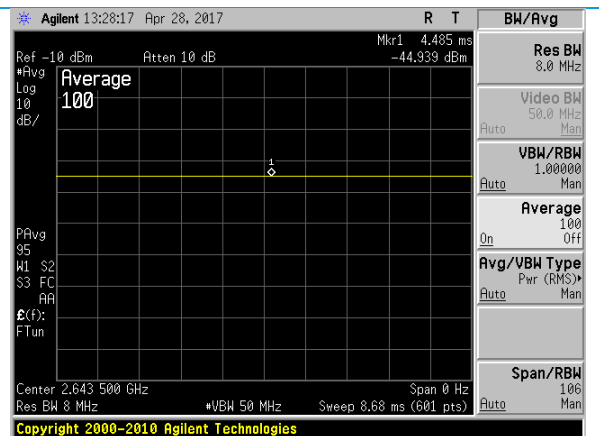
2360 MHz



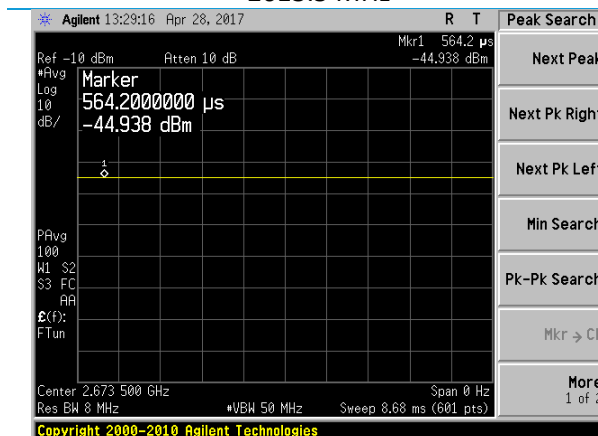
2583.5 MHz



2613.5 MHz



2643.5 MHz



2673.5 MHz

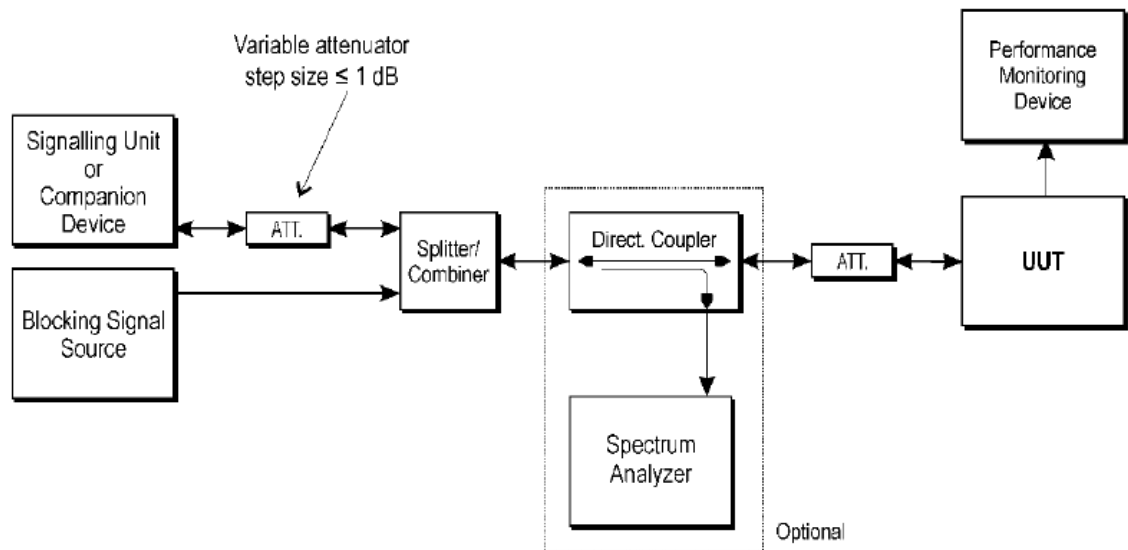
5.2 Antenna Port Conducted Emissions – Receiver Blocking BLE

Operator	Aidi Zainal
QA	Adam Alger
Test Date	2/11/2017
Location	Screen room
Temp. / R.H.	20-25° C / 30-50 % R.H.
Requirement	ETSI EN 300 328 V2.1.1 Section 4.3.2.11
Method	ETSI EN 300 328 V2.1.1 Section 5.4.11

Table 15: Receiver Blocking parameters receiver category 2 equipment

Wanted signal mean power from companion device (dBm)	Blocking signal frequency (MHz)	Blocking signal power (dBm) (see note 2)	Type of blocking signal
$P_{min} + 6 \text{ dB}$	2 380 2 503,5	-57	CW
$P_{min} + 6 \text{ dB}$	2 300 2 583,5	-47	CW
NOTE 1: P_{min} is the minimum level of the wanted signal (in dBm) required to meet the minimum performance criteria as defined in clause 4.3.2.11.3 in the absence of any blocking signal.			
NOTE 2: The levels specified are levels in front of the UUT antenna. In case of conducted measurements, the levels have to be corrected by the actual antenna assembly gain.			

Block Diagram



Instrumentation



No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960088	MXE Spectrum Analyzer	Agilent	N9038A	MY51210138	2/24/2016	2/23/2017	Active Calibration
2	CC 000284C	Signal Generator	Agilent	E4421B	MY41000402	11/17/2016	11/17/2017	Active Verification
3	EE 960093	Splitter/Combiner	mini-circuits	ZFSC-2-10G	SF702900616	2/27/2017	2/27/2018	Active Verification

Test Parameters

Mode	BLE 4.0
Rx Category	2
Minimum Performance	0.1% BER = 30.8% PER
EUT Serial	26
Companion / Monitoring Device	Litepoint

Setup Parameters

Frequency (MHz)	Litepoint level	Var. Att (dB)
2402	-43.0	17.0
2480	-42.5	17.0

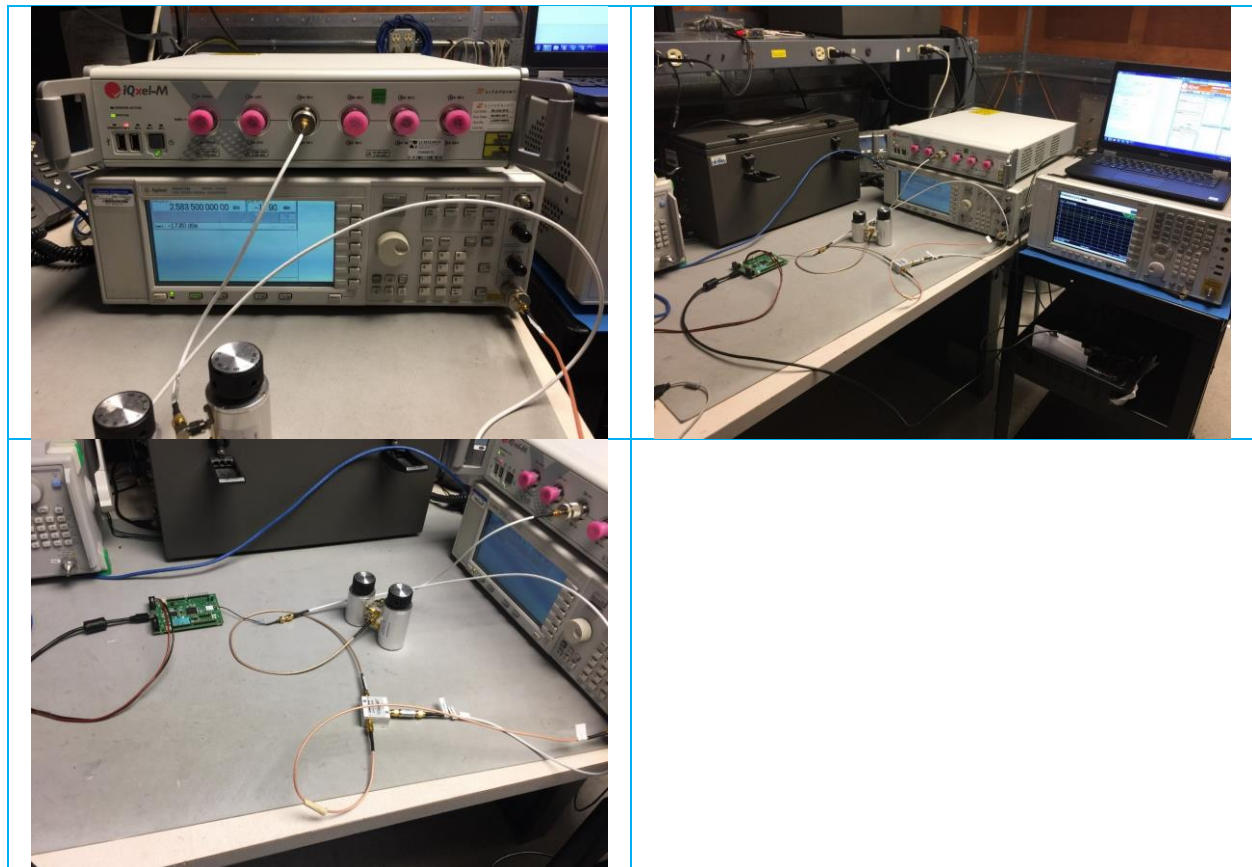
Frequency (MHz)	Level	Ant Gain	Blocking level	Sig gen setting (dBm)
2380.0	-57.0	2.0	-55.0	-27.5
2503.5	-57.0	2.0	-55.0	-27.5
2300.0	-47.0	2.0	-45.0	-18.0
2583.5	-47.0	2.0	-45.0	-17.9

Results

Data rate	EUT Channel	Result at Blocking frequencies listed			
		2380	2503.5	2300	2583.5
BLE 4.0	2402	Pass	Pass	Pass	Pass
BLE 4.0	2480	Pass	Pass	Pass	Pass

Test Notes	1 - Found a 30.8% PER per 0.1% bit error rate based on Bluetooth Sig Spec (see note 4-5).
	2 - Minimum performance declared by customer at 30.8% PER (see note 1).
	3 - In addition to variable attenuation, path has a 20dB pad and cable losses.
	4 - You can calculate the BER directly from the PER. The BT Sig Spec calls for testing sensitivity with a PER limit of 30.8%. This translates to a BER of 0.1% while using the max BLE packet size (37 octet payload). I would recommend just testing PER with a pass/fail threshold of 30.8%.
	5 - The calculation is as follows: Assume a model receiver where all the bits have the same error probability and bit errors are statistically independent events. If any bit in the packet, except for the preamble, is incorrect, the packet will be lost, as the access address has to be error-free if the packet is to be received, and the header and payload is protected with CRC. This means that 368 bits have to be received error-free for the maximum length packet to be received correctly. If the bit error rate is 0.1%, or 0.001, this means that the packet error rate is: $1 - ((1 - 0.001)^{368}) = 0.308010241105056$

Setup Photos



Company: Laird

Report: TR 317050

Job: C-2678

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Name: Sterling-LWB

Model: Sterling-LWB

Serial: See Section 2.1

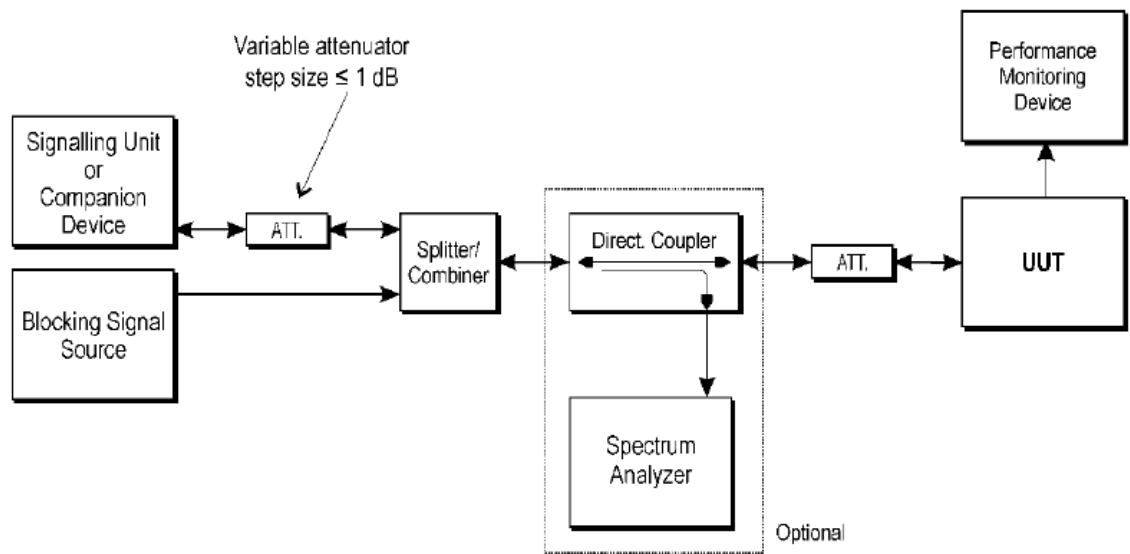
5.3 Antenna Port Conducted Emissions – Receiver Blocking WLAN

Operator	Zach Wilson
QA	Adam Alger
Test Date	Feb. 9, 10 2017
Location	Screen room
Temp. / R.H.	20-25° C / 30-50 % R.H.
Requirement	ETSI EN 300 328 V2.1.1 Section 4.3.2.11
Method	ETSI EN 300 328 V2.1.1 Section 5.4.11

Receiver Blocking parameters receiver category 1 equipment

Wanted signal mean power from companion device (dBm)	Blocking signal frequency (MHz)	Blocking signal power (dBm) (see note 2)	Type of blocking signal
$P_{min} + 6 \text{ dB}$	2 380 2 503,5	-53	CW
$P_{min} + 6 \text{ dB}$	2 300 2 330 2 360	-47	CW
$P_{min} + 6 \text{ dB}$	2 523,5 2 553,5 2 583,5 2 613,5 2 643,5 2 673,5	-47	CW
NOTE 1: P_{min} is the minimum level of wanted signal (in dBm) required to meet the minimum performance criteria as defined in clause 4.3.1.12.3 in the absence of any blocking signal. NOTE 2: The levels specified are levels in front of the UUT antenna. In case of conducted measurements, the levels have to be corrected by the actual antenna assembly gain.			

Block Diagram



Instrumentation



No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960088	MXE Spectrum Analyzer	Agilent	N9038A	MY51210138	2/24/2016	2/23/2017	Active Calibration
2	CC 000284C	Signal Generator	Agilent	E4421B	MY41000402	11/17/2016	11/17/2017	Active Verification
3	EE 960093	Splitter/Combiner	mini-circuits	ZFSC-2-10G	SF702900616	2/27/2017	2/27/2018	Active Verification

Test Parameters

Mode	WLAN 802.11bgn (1 Mbps, 6 Mbps, MCS 0 HT 20)
Rx Category	1
Minimum Performance	10% PER
EUT Serial	16
Companion / Monitoring Device	Litepoint

Setup Parameters

1 MBPS Data Rate		
Frequency (MHz)	Litepoint level	Attenuation (dB)
2412	-43.5	17
2472	-43	17

6 MBPS Data Rate		
Frequency (MHz)	Litepoint level	Attenuation (dB)
2412	-38.5	17
2472	-37.5	17

MCSO HT20 MBPS Data Rate		
Frequency (MHz)	Litepoint level	Attenuation (dB)
2412	-38.5	17
2472	-37.5	17

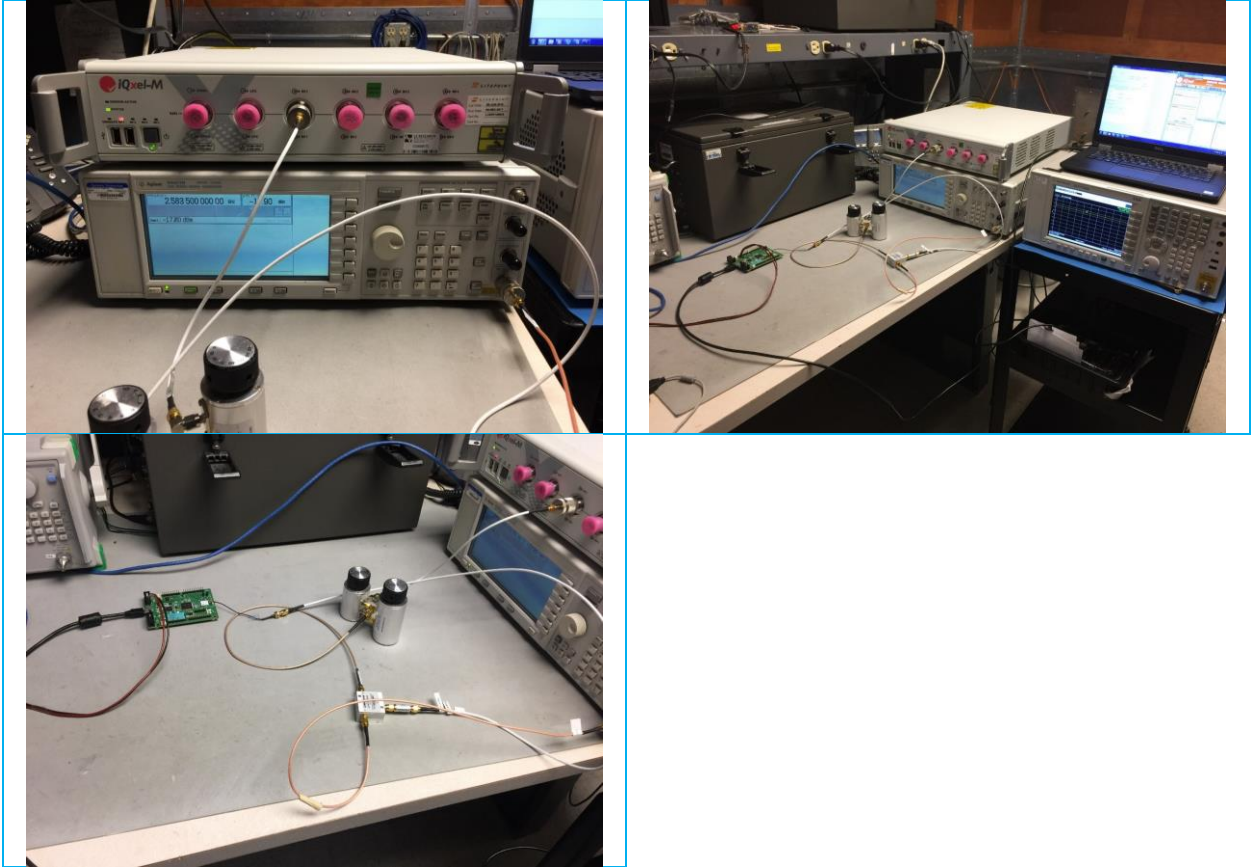
Setup Parameters

Frequency (MHz)	Level	Ant Gain	Blocking level	Sig gen setting (dBm)
2380.0	-53.0	2.0	-51.0	-23.8
2503.5	-53.0	2.0	-51.0	-23.9
2300.0	-47.0	2.0	-45.0	-17.8
2330.0	-47.0	2.0	-45.0	-17.8
2360.0	-47.0	2.0	-45.0	-17.7
2523.5	-47.0	2.0	-45.0	-17.7
2553.5	-47.0	2.0	-45.0	-17.7
2583.5	-47.0	2.0	-45.0	-17.7
2613.5	-47.0	2.0	-45.0	-17.7
2643.5	-47.0	2.0	-45.0	-17.6
2673.5	-47.0	2.0	-45.0	-17.6

Results

Mode	Data rate	EUT Channel	Result at Blocking frequencies listed										
			2380	2503.5	2300	2330	2360	2523.5	2553.5	2583.5	2613.5	2643.5	2673.5
802.11b	1MBPS	2412	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
802.11g	6MBPS	2412	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
802.22n	MCS0 HT20	2412	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
802.11b	1MBPS	2472	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
802.11g	6MBPS	2472	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
802.22n	MCS0 HT20	2472	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass

Setup Photos



5.4 Radiated Immunity

The EUT is illuminated with uniform electromagnetic radiation by means of a RF generator, power amplifier, and field generating antenna.

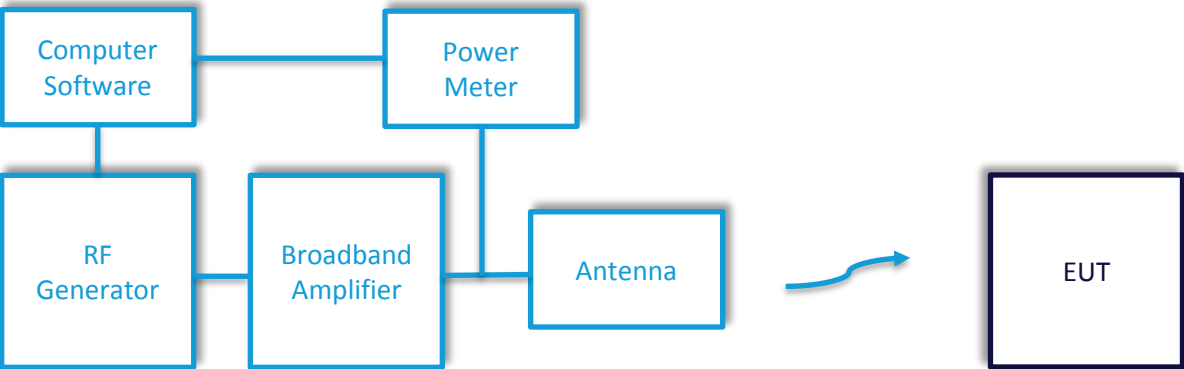
Ferrite panels and/or absorbers are placed on the ground between the antenna and EUT to achieve a uniform field area. The UFA is measured with an isotropic probe positioned in a planar grid at the desired test distance.

Description of Measurement

The power required to create a uniform test field strength is stored in a calibration file for each frequency and antenna polarity.

The response of the EUT during and after test is observed, recorded, and compared to the defined performance criteria.

Block Diagram



5.4.1 Radiated Immunity (Bluetooth)

Operator	Zach Wilson
QA	Shane Dock
Test Date	5/25/2017 (BT)
Location	Chamber 5
Temp. / R.H.	70° F / 45 %
Requirement	ETSI EN 301 489-17, ETSI EN 301 489-1
Method	EN 61000-4-3

Test Parameters

Frequency	1.0 - 6.0 GHz, Exclusion Band 2280-2603.5 MHz
Level	3 V/m (horizontal and vertical antenna polarity)
Modulation	80% 1 kHz Sine Wave
Step / Dwell	Logarithmic 1%, 3 sec
Power	USB
Tx Mode	BT Classic (BLE mode not tested)
Monitoring	Using BlueTool to Tx and Rx with another LWB unit. EUT not to drop link.
EUT Orientation	Front, Back

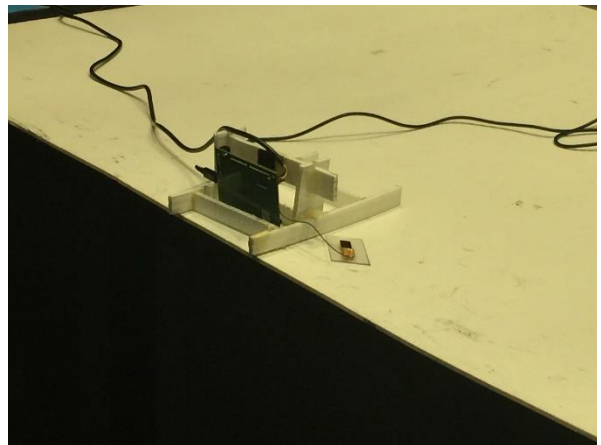
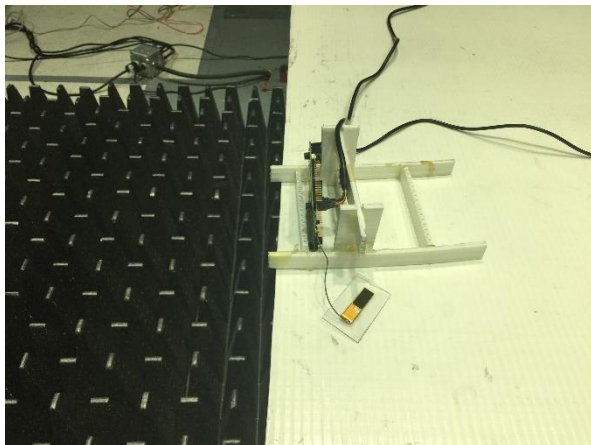
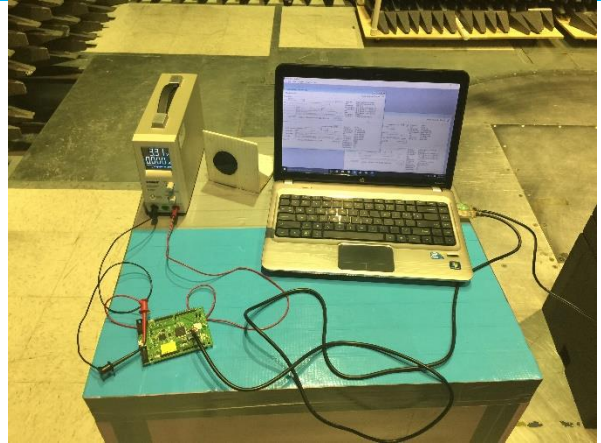
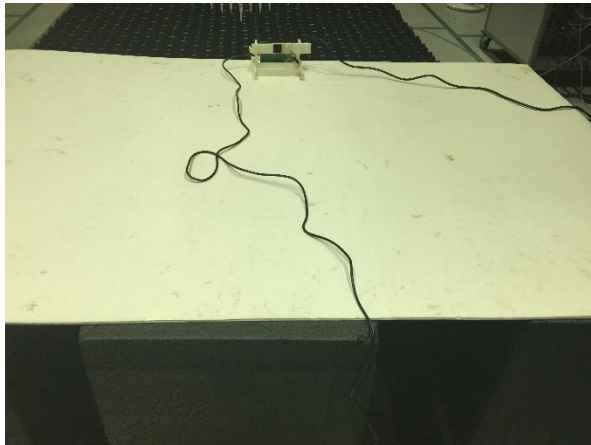
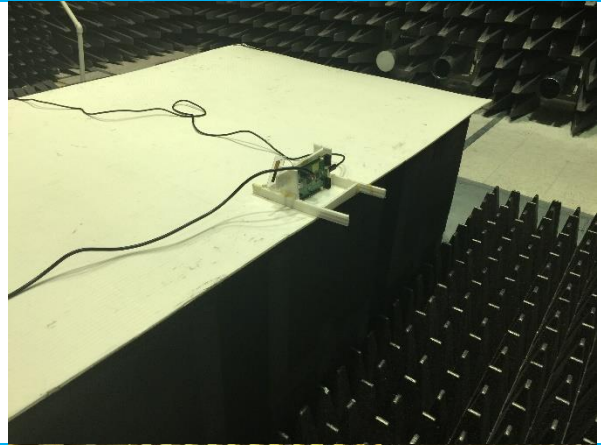
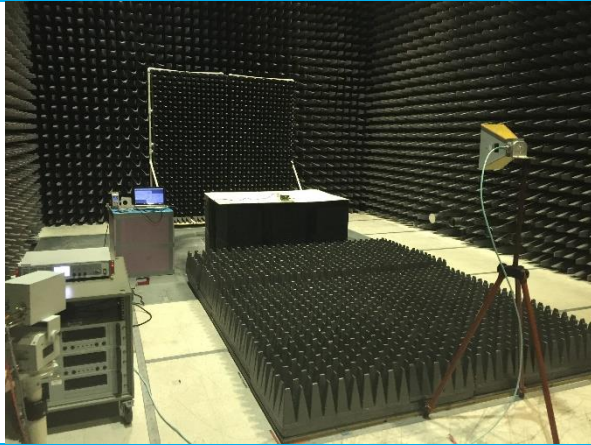
Instrumentation



No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960098	RF Generator	Teseq	ITS 6006	33022	1/23/2017	1/23/2018	Active Calibration
2	EE 960099	Power Meter	Teseq	PM 6006	73409	1/23/2017	1/23/2018	Active Calibration
3	EE 960101	Power Meter	Teseq	PM 6006	73410	1/23/2017	1/23/2018	Active Calibration
4	AA 960081	Double Ridge Horn Antenna	EMCO	3115	6907	3/17/2017	3/17/2018	Active Calibration
5	EE 960108	Power Amplifier	Milmega	AS1860-100	1060507	3/5/2017	3/5/2018	Active Validation
6	EE 960107	Power Amplifier	Milmega	AS0102-250	1060508	3/5/2017	3/5/2018	Active Validation

Setup Photos

BT Classic



Radiated Immunity (WLAN)

Operator	Zach Wilson
QA	Adam Alger
Test Date	6/08/2017
Location	Chamber 5
Temp. / R.H.	70° F / 50 %
Requirement	ETSI EN 301 489-17, ETSI EN 301 489-1
Method	EN 61000-4-3

Test Parameters

Frequency	1.0 - 6.0 GHz, Exclusion Band 2280-2603.5 MHz
Level	3 V/m (horizontal and vertical antenna polarity)
Modulation	80% 1 kHz Sine Wave
Step / Dwell	Logarithmic 1%, 3 sec
Power	USB
Tx Mode	WLAN
Monitoring	Using Cisco AP and iPerf to create a continuous Tx/Rx. EUT set up as client. EUT not to drop link
EUT Orientation	Front, Back
Note	Issue at 1220, & 2603.5 - 2683.28 MHz, drops packets but keeps link

Instrumentation

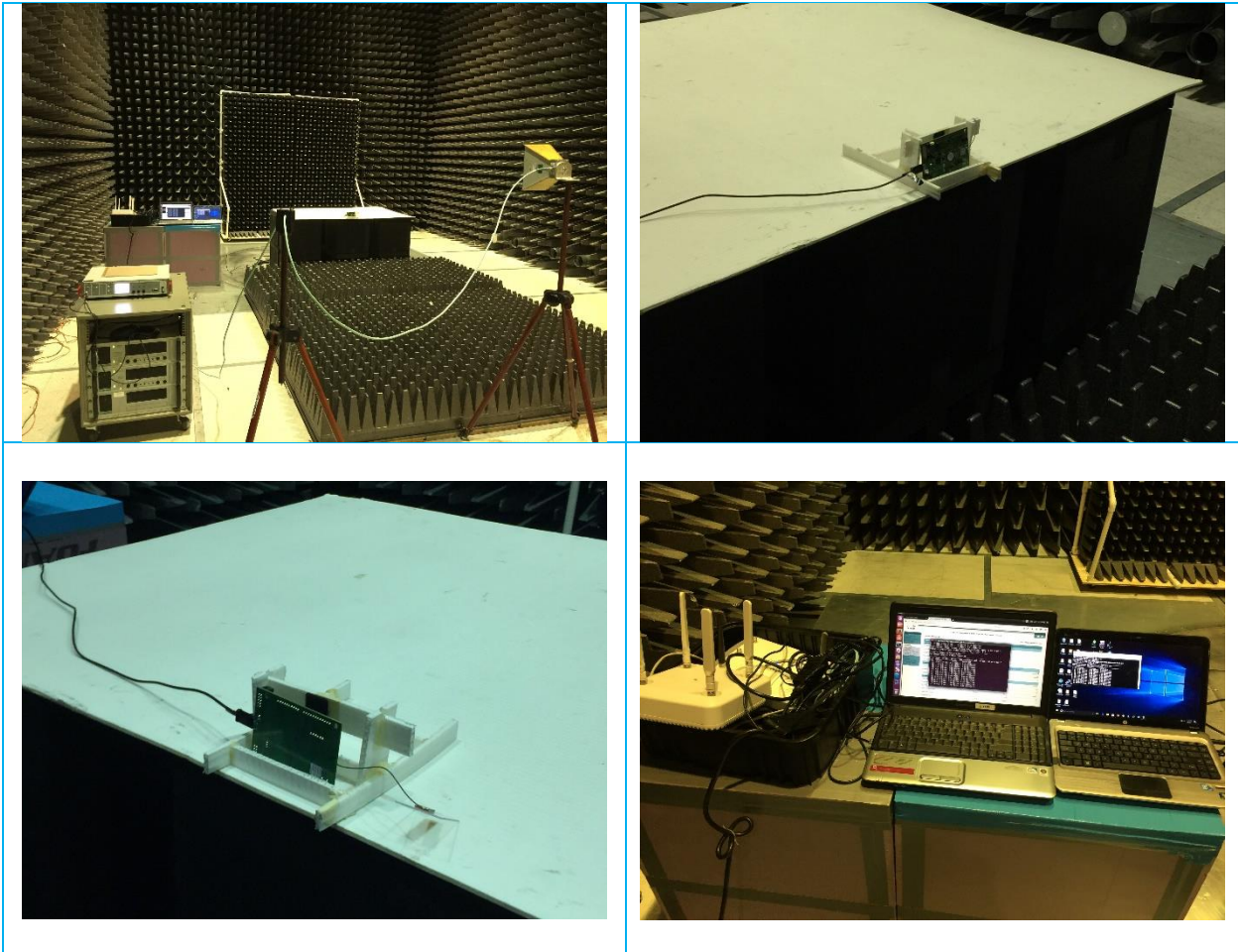


No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960098	RF Generator	Teseq	ITS 6006	33022	1/23/2017	1/23/2018	Active Calibration
2	EE 960099	Power Meter	Teseq	PM 6006	73409	1/23/2017	1/23/2018	Active Calibration
3	EE 960101	Power Meter	Teseq	PM 6006	73410	1/23/2017	1/23/2018	Active Calibration
4	AA 960081	Double Ridge Horn Antenna	EMCO	3115	6907	3/17/2017	3/17/2018	Active Calibration
5	EE 960108	Power Amplifier	Milmega	AS1860-100	1060507	3/5/2017	3/5/2018	Active Validation
6	EE 960107	Power Amplifier	Milmega	AS0102-250	1060508	3/5/2017	3/5/2018	Active Validation

Company: Laird	Page 26 of 28	Name: Sterling-LWB
Report: TR 317050		Model: Sterling-LWB
Job: C-2678		Serial: See Section 2.1

Setup Photos

WLAN



6 REVISION HISTORY

Version	Date	Notes	Person
V0	6/09/2017	Draft	Adam Alger
V1	6/11/2017	Review	Ryan Urness
V1	6/12/2017	Release	Adam Alger

END OF REPORT