

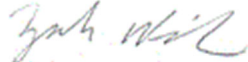
Test Report # 319345 G

Equipment Under Test: Sterling LWB

Test Date(s): April 24th, 2020 and June 8th, 2020

Prepared for: Laird Connectivity
Attn: Jonathan Kaye
50 South Main Street, Suite 1100
Akron, OH 44308

Report Issued by: Zach Wilson, EMC Engineer

Signature: 

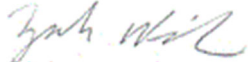
Date: 12/22/2020

Report Reviewed by: Adam Alger, Quality Manager

Signature: 

Date: 12/22/2020

Report Constructed by: Zach Wilson, EMC Engineer

Signature: 

Date: 12/15/2020

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Laird Connectivity Test Services in Review

The Laird Connectivity, 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 17025:2017 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 Test Firm Registration Number: 953492

Recognition of two 3 meter Semi-Anechoic Chambers



Innovation, Science and Economic Development Canada

Accredited U.S. Identification Number: US0218

Recognition of two 3 meter Semi-Anechoic Chambers

Company: Laird Connectivity	Page 3 of 19	Name: Sterling LWB
Report: TR319345 G		Model: Sterling LWB
Job: C-3352		Serial: Engineering Sample

1 TEST REPORT SUMMARY

During **April 24th, 2020 and June 8th, 2020**, the Equipment Under Test (EUT), **Sterling LWB**, as provided by **Laird Connectivity** was tested to the following requirements:

ETSI EN 300 328 v2.2.2 – Other Types of Wide Band Modulation

Requirement	Description	Specification	Method	Result
4.3.2.11	Receiver Blocking	PER ≤ 10%	5.4.11	Pass

ETSI EN 300 328 v2.2.2 – Frequency Hopping Equipment

Requirement	Description	Specification	Method	Result
4.3.1.12	Receiver Blocking	PER ≤ 10%	5.4.11	Pass

Notice:

The results relate only to the item tested as configured and described in this report. Any additional configurations, modes of operation, or modifications made to the equipment under test after the specified test date(s) are at the decision of the client and may not apply to the data seen in this test report.

The decision rule for Pass / Fail assessment to the specification or standard listed in this test report has been agreed upon by the client and laboratory to be as follows:

Measurement Type	Rule
Emissions – Amplitude	1 dB below specified limit
Emissions – Frequency	1% less than the specification
Immunity	Tested at specified level

2 CLIENT INFORMATION

Company Name	Laird Connectivity
Contact Person	Jonathan Kaye
Address	50 South Main Street, Suite 1100 Akron, OH 44308

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	Engineering Sample
FCC ID	TFB-1003
IC ID	5969A-1003

2.2 Product Description

The EUT contains dual-band WIFI and Bluetooth 4.2 radios. The EUT uses the Cypress CYW4343W chipset. The temperature rating is -40°C to +85°C.

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 Power Information

The EUT was powered at 3.3VDC by a lab power supply.

2.6 Programming Information

The radios were programmed for test modes using TeraTerm v4.99.

2.7 Radio Configuration

Protocol	Data Rate	Max Output Power (dBm)	Max Antenna Gain (dBi)	Max EIRP (dBm)
802.11b/g/n	All Rates	24	2.0	26.0
BLE	1Mbps	7.5	2.0	9.5
BT Classic	1Mbps	8.9	2.0	10.9

Protocol	Data Rate	Channel	OCBW (Hz)
802.11b	1Mbps	1	13896000
802.11b	1Mbps	13	13896000
802.11g	6Mbps	1	16417000
802.11g	6Mbps	13	16417000
802.11n	MCS0	1	17566000
802.11n	MCS0	13	17566000

Protocol	Data Rate	Channel	OCBW (Hz)
BLE	1Mbps	0	1100000
BLE	1Mbps	39	1100000

Protocol	Data Rate	Channel	OCBW (Hz)
BT Classic	1Mbps	Hopping	9000000

Radio	Channels	Data Rates
WLAN 2.4	1 (2412MHz), 13 (2472MHz)	802.11b 1 Mbps
WLAN 2.4	1 (2412MHz), 13 (2472MHz)	802.11g 6 Mbps
WLAN 2.4	1 (2412MHz), 13 (2472MHz)	802.11n MCS0
BLE	0 (2402MHz), 39 (2480MHz)	BLE DR
BT Classic	0 (2402MHz), 79 (2480MHz)	BTDR 1 Mbps

2.8 Antenna

Laird dipole with a peak antenna gain of 2.0dBi at 2.4GHz.

3 REFERENCES

Publication	Edition	Date
ETSI 300 328	v2.2.2	07-2019

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

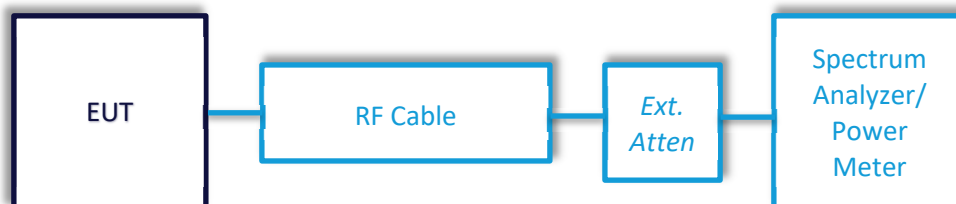
Parameter	ETSI U.C. $\pm$	U.C. $\pm$
Radio Frequency, from F0	1×10^{-7}	0.55×10^{-7}
Occupied Channel Bandwidth	5 %	2 %
RF conducted Power (Power Meter)	1.5 dB	1.2 dB
RF conducted emissions (Spectrum Analyzer)	3.0 dB	1.7 dB
All emissions, radiated	6.0 dB	5.3 dB
Temperature	1° C	0.65° C
Humidity	5 %	2.9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

5 TEST DATA

5.1 Antenna Port Conducted Emissions

Description of Measurement	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. The cable and attenuator factors are loaded into the analyzer or power meter allowing for direct measurement readings without the need for further corrections.
Example Calculations	Measurement (dBm) + Cable factor (dB) + External Attenuator (dB) = Corrected Reading (dBm) Margin (dB) = Limit (dBm) – Corrected Reading (dBm)

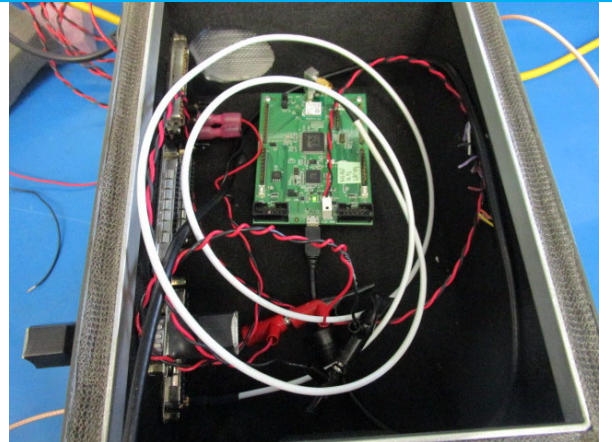
Block Diagram



Setup Photos



Test Setup



Test Setup

Instrumentation



Date: 10-Jul-2020

Test: Receiver Blocking

Job: C-3352

PE: Zach Wilson

Customer: Laird Connectivity

Quote: 319345

No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	AA 960180	Attenuator - Step Variable 1 dB	RF Lambda	RKT2G6A10	16100801	2/14/2020	2/14/2021	Active Verification
2	AA 960181	Attenuator - Step Variable 10 dB	RF Lambda	RKT2G6A60	16102401	2/14/2020	2/14/2021	Active Verification
3	AA 960182	RF Splitter/Combiner	Mini-Circuits	ZFSC-2-10G+	F707701704	6/7/2018	6/7/2021	Active Verification
4	CC 000314C	Vector Signal Generator	Agilent	E4438C	US 41469143	7/31/2019	7/31/2022	Active Calibration
5	EE 960098	Analyzer - EMI Receiver	Agilent	N9038A	MY51210138	7/14/2019	7/14/2021	Active Calibration
6	CC 000817C	Litepoint	Litepoint	IQXEL-M	IQM600169	5/7/2019	5/7/2020	Active Calibration
7	CC 000828C	CBT - Bluetooth Tester	Rhode and Schwartz	CBT	100174	12/12/2019	12/12/2020	Active Calibration

5.1.1 Receiver Blocking - WLAN 2.4GHz

Operator	Anthony Smith
QA	Aidi Zainal
Test Date	4/24/2020, 6/8/2020
Location	Radio Bench
Temp. / R.H.	21.8°C/29.1%, 21.6°C/64.4%
Requirement	ETSI 300 328 §4.3.2.11.4.2
Method	ETSI 300 328 §5.4.11

Limit: PER < 10%

Test Parameters

Receiver Category	1
EUT Input Power	3.3VDC
Performance Criteria	PER < 10%
Radio Mode	WLAN 2.4 Receive
Antenna Gain	2.0dBi
Max Peak Output Power	10dBm
E.I.R.P	12dBm
AE	Laptop for Programming
Number of Packets Sent	802.11b: 1000 802.11g/n: 2000
Data Rate	802.11b: 1Mbps 802.11g: 6Mbps 802.11n: MCS0
Example Calculation	$(-133 \text{ dBm} + 10 \times \text{LOG}_{10}(\text{OCBW})) = \text{Wanted Signal Mean Power From Companion (dBm)}$

Table 14: Receiver Blocking parameters for Receiver Category 1 equipment

Wanted signal mean power from companion device (dBm) (see notes 1 and 4)	Blocking signal frequency (MHz)	Blocking signal power (dBm) (see note 4)	Type of blocking signal
(-133 dBm + 10 × log ₁₀ (OCBW)) or -68 dBm whichever is less (see note 2)	2 380 2 504	-34	CW
(-139 dBm + 10 × log ₁₀ (OCBW)) or -74 dBm whichever is less (see note 3)	2 300 2 330 2 360 2 524 2 584 2 674		

NOTE 1: OCBW is in Hz.

NOTE 2: In case of radiated measurements using a companion device and the level of the wanted signal from the companion device cannot be determined, a relative test may be performed using a wanted signal up to $P_{\min} + 26$ dB where $P_{\min}$ is the minimum level of wanted signal required to meet the minimum performance criteria as defined in clause 4.3.1.12.3 in the absence of any blocking signal.

NOTE 3: In case of radiated measurements using a companion device and the level of the wanted signal from the companion device cannot be determined, a relative test may be performed using a wanted signal up to $P_{\min} + 20$ dB where $P_{\min}$ is the minimum level of wanted signal required to meet the minimum performance criteria as defined in clause 4.3.1.12.3 in the absence of any blocking signal.

NOTE 4: The level specified is the level at the UUT receiver input assuming a 0 dBi antenna assembly gain. In case of conducted measurements, this level has to be corrected for the (in-band) antenna assembly gain (G). In case of radiated measurements, this level is equivalent to a power flux density (PFD) in front of the UUT antenna with the UUT being configured/positioned as recorded in clause 5.4.3.2.2.

Data Tables

Protocol	Data Rate	Channel	OCBW (Hz)	OCBW Derived Wanted Signal Mean Power (dBm)
802.11b	1Mbps	1	13896000	-61.6
802.11b	1Mbps	13	13896000	-67.6
802.11g	6Mbps	1	16417000	-60.8
802.11g	6Mbps	13	16417000	-66.8
802.11n	MCS0	1	17566000	-60.6
802.11n	MCS0	13	17566000	-66.6

Blocking Signal Frequency (MHz)	Wanted Signal Mean Power from Companion Device (dBm)	Antenna Gain (dBi)	Corrected Companion Power Used (dBm)
2380	-68.0	2.0	-70.0
2504	-68.0	2.0	-70.0
2300	-74.0	2.0	-76.0
2330	-74.0	2.0	-76.0
2360	-74.0	2.0	-76.0
2524	-74.0	2.0	-76.0
2584	-74.0	2.0	-76.0
2674	-74.0	2.0	-76.0

Blocking Frequency (MHz)	Blocking Signal Power (dBm)	Antenna Gain (dBi)	Corrected Blocking Level (dBm)	Sig Gen Level (dBm)
2380.0	-34.0	2.0	-32.0	-23.5
2504.0	-34.0	2.0	-32.0	-23.5
2300.0	-34.0	2.0	-32.0	-23.5
2330.0	-34.0	2.0	-32.0	-23.5
2360.0	-34.0	2.0	-32.0	-23.5
2524.0	-34.0	2.0	-32.0	-23.5
2584.0	-34.0	2.0	-32.0	-23.3
2674.0	-34.0	2.0	-32.0	-23.3

Radio Mode	Data Rate	EUT Channel	Blocking Signal Frequency (MHz)								Packets
			2380.0	2504.0	2300.0	2330.0	2360.0	2524.0	2584.0	2674.0	
			PER %								
802.11b	1Mbps	1	0.000	N/A	1.800	2.700	0.800	N/A	N/A	N/A	1000
802.11b	1Mbps	13	N/A	0	N/A	N/A	N/A	0.2	0.7	1.2	1000
802.11g	6Mbps	1	1.85	N/A	2.85	3.8	4.75	N/A	N/A	N/A	2000
802.11g	6Mbps	13	N/A	0	N/A	N/A	N/A	0	1.7	1.9	2000
802.11n	MCS0	1	1.8	N/A	5	5.95	2.54	N/A	N/A	N/A	2000
802.11n	MCS0	13	N/A	0	N/A	N/A	N/A	0	1.35	1.55	2000

5.1.2 Receiver Blocking - Bluetooth Low Energy (BLE)

Operator	Anthony Smith
QA	Aidi Zainal
Test Date	6/5/2020
Location	Radio Bench
Temp. / R.H.	20.7°C/66.2%
Requirement	ETSI 300 328 §4.3.2.11.4.2
Method	ETSI 300 328 §5.4.11

Limit: PER < 10%

Test Parameters

Receiver Category	2
EUT Input Power	3.3VDC
Performance Criteria	PER < 10%
Radio Mode	BLE Receive
Antenna Gain	2.0dBi
Max Peak Output Power	0.0dBm
E.I.R.P	2.0dBm
AE	Laptop for Programming
Number of Packets Sent	1000
Data Rate	BLE 4.0
Example Calculation	$(-139 \text{ dBm} + 10 \times \text{LOG}_{10}(\text{OCBW}) + 10 \text{ dB}) = \text{Wanted Signal Mean Power from Companion (dBm)}$

Table 15: Receiver Blocking parameters receiver Category 2 equipment

Wanted signal mean power from companion device (dBm) (see notes 1 and 3)	Blocking signal frequency (MHz)	Blocking signal power (dBm) (see note 3)	Type of blocking signal
(-139 dBm + 10 × log ₁₀ (OCBW) + 10 dB) or (-74 dBm + 10 dB) whichever is less (see note 2)	2 380 2 504 2 300 2 584	-34	CW
NOTE 1: OCBW is in Hz. NOTE 2: In case of radiated measurements using a companion device and the level of the wanted signal from the companion device cannot be determined, a relative test may be performed using a wanted signal up to $P_{min} + 26$ dB where P_{min} is the minimum level of wanted signal required to meet the minimum performance criteria as defined in clause 4.3.1.12.3 in the absence of any blocking signal. NOTE 3: The level specified is the level at the UUT receiver input assuming a 0 dBi antenna assembly gain. In case of conducted measurements, this level has to be corrected for the (in-band) antenna assembly gain (G). In case of radiated measurements, this level is equivalent to a power flux density (PFD) in front of the UUT antenna with the UUT being configured/positioned as recorded in clause 5.4.3.2.2.			

Data Tables

Protocol	Data Rate	Channel	OCBW (Hz)	OCBW Derived Wanted Signal Mean Power (dBm)
BLE	1Mbps	0	1100000	-68.6
BLE	1Mbps	39	1100000	-68.6

Blocking Signal Frequency (MHz)	Wanted Signal Mean Power from Companion Device (dBm)	Antenna Gain (dBi)	Corrected Companion Power Used (dBm)
2380	-68.6	2.0	-70.6
2504	-68.6	2.0	-70.6
2300	-68.6	2.0	-70.6
2584	-68.6	2.0	-70.6

Blocking Frequency (MHz)	Blocking Signal Power (dBm)	Antenna Gain (dBi)	Corrected Blocking Level (dBm)	Signal Generator Level (dBm)
2380.0	-34.0	2.0	-32.0	-25.3
2504.0	-34.0	2.0	-32.0	-25.3
2300.0	-34.0	2.0	-32.0	-25.3
2584.0	-34.0	2.0	-32.0	-25.2

Radio Mode	Data Rate	EUT Channel	Blocking Signal Frequency (MHz)				Packets	Result
			2380.0	2504.0	2300.0	2584.0		
			PER %					
Bluetooth Low Energy	BLE 4.0	0	0.000	0.000	0.000	0.000	1000	Pass
Bluetooth Low Energy	BLE 4.0	39	0.000	0.000	0.000	0.000	1000	Pass

5.1.3 Receiver Blocking – Bluetooth Classic

Operator	Anthony Smith
QA	Aidi Zainal
Test Date	6/5/2020
Location	Radio Bench
Temp. / R.H.	20.8°C/67.0%
Requirement	ETSI 300 328 §4.3.1.12
Method	ETSI 300 328 §5.4.11

Limit: PER < 10%

Test Parameters

Receiver Category	1
EUT Input Power	3.3VDC
Performance Criteria	PER < 10%
Radio Mode	BT Classic, Hopping
Antenna Gain	2.0dBi
Max Peak Output Power	8.9dBm
E.I.R.P	10.9dBm
AE	Laptop for Programming
Number of Packets Sent	n/a, hopping
Data Rate	DH1 Hopping
Example Calculation	$(-133 \text{ dBm} + 10 \times \text{LOG}_{10}(\text{OCBW})) = \text{Wanted Signal Mean Power from Companion (dBm)}$

Table 6: Receiver Blocking parameters for Receiver Category 1 equipment

Wanted signal mean power from companion device (dBm) (see notes 1 and 4)	Blocking signal frequency (MHz)	Blocking signal power (dBm) (see note 4)	Type of blocking signal
$(-133 \text{ dBm} + 10 \times \log_{10}(\text{OCBW}))$ or -88 dBm whichever is less (see note 2)	2 380 2 504	-34	CW
$(-139 \text{ dBm} + 10 \times \log_{10}(\text{OCBW}))$ or -74 dBm whichever is less (see note 3)	2 300 2 330 2 360 2 524 2 584 2 674		
NOTE 1: OCBW is in Hz.			
NOTE 2: In case of radiated measurements using a companion device and the level of the wanted signal from the companion device cannot be determined, a relative test may be performed using a wanted signal up to $P_{\min} + 26 \text{ dB}$ where $P_{\min}$ is the minimum level of wanted signal required to meet the minimum performance criteria as defined in clause 4.3.1.12.3 in the absence of any blocking signal.			
NOTE 3: In case of radiated measurements using a companion device and the level of the wanted signal from the companion device cannot be determined, a relative test may be performed using a wanted signal up to $P_{\min} + 20 \text{ dB}$ where $P_{\min}$ is the minimum level of wanted signal required to meet the minimum performance criteria as defined in clause 4.3.1.12.3 in the absence of any blocking signal.			
NOTE 4: The level specified is the level at the UUT receiver input assuming a 0 dBi antenna assembly gain. In case of conducted measurements, this level has to be corrected for the (in-band) antenna assembly gain (G). In case of radiated measurements, this level is equivalent to a power flux density (PFD) in front of the UUT antenna with the UUT being configured/positioned as recorded in clause 5.4.3.2.2.			

Data Tables

Protocol	Data Rate	Channel	OCBW (Hz)	OCBW Derived Wanted Signal Mean Power (dBm)
BT Classic	1Mbps	Hopping	856000	-73.7

Blocking Frequency (MHz)	Blocking Signal Power (dBm)	Antenna Gain (dBi)	Corrected Blocking Level (dBm)	Signal Generator Level (dBm)
2380.0	-34.0	2.0	-32.0	-25.3
2504.0	-34.0	2.0	-32.0	-25.3
2300.0	-34.0	2.0	-32.0	-25.3
2584.0	-34.0	2.0	-32.0	-25.2
2330.0	-34.0	2.0	-32.0	-25.3
2360.0	-34.0	2.0	-32.0	-25.3
2524.0	-34.0	2.0	-32.0	-25.3
2674.0	-34.0	2.0	-32.0	-25.1

Radio Mode	Data Rate	EUT Channel	Blocking Signal Frequency (MHz)								Packets	Result
			2380.0	2504.0	2300.0	2330.0	2360.0	2524.0	2584.0	2674.0		
			PER %									
BT Hopping	1Mbps DH1	Hopping	0.09	0.20	0.28	0.44	0.31	0.36	0.26	0.27	7408	Pass

6 REVISION HISTORY

Version	Date	Notes	Person
v0	12/15/2020	Initial Draft	Zach Wilson
v1	12/22/2020	Revised per internal review	Zach Wilson

END OF REPORT