

Test Report C-3652-6

Equipment Under Test: Sterling LWB

Requirement(s): IEC 62311

Test Date(s): 12/16/2022

Prepared for: Laird Connectivity
Attn: Senthoran Ragavan
W66 N220 Commerce Ct.
Cedarburg, WI 53012

Report Issued by: Dylan Rosenfeldt, EMC Engineer

Signature: 

Date: 01/03/2023

Report Reviewed by: Adam Alger, Laboratory Manager

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Date: 01/03/2023

Report Constructed by: Dylan Rosenfeldt, EMC Engineer

Signature: 

Date: 01/03/2023

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Laird Connectivity Test Services in Review

The Laird Connectivity LLC 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 12	Name: Sterling LWB
Report: TR 3652-6		Model: LWB
Quote: NBO-12-2022-005613		Serial: Engineering Sample

1 TEST REPORT SUMMARY

During **12/16/2022** the Equipment Under Test (EUT), **Sterling LWB**, as provided by **Laird Connectivity** was tested to the following requirements:

Requirements	Description	Method	Compliant
IEC 62311	Assessment of electronic and electrical equipment related to human exposure restrictions for electromagnetic fields	IEC 62311 Annex A	Yes

Note: IEC 62311 is not on Laird Connectivity's Scope of Accreditation

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	Senthooran Ragavan
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	Engineering Sample

2.2 Product Description

The Sterling-LWB is a high performance 2.4 GHz WLAN and Bluetooth combo module based on latest-generation silicon (Infineon's CYW4343W).

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.

Chip Antenna: Johanson Part # 2450AT18D0100 Peak Gain 1.5 dBi

U.FL Antenna port utilizes the following antenna options:

LSR 2.4 GHz Dipole Antenna 2dBi

LSR 2.4 GHz FlexPIFA 2dBi

LSR 2.4 GHz FlexNotch 2dBi

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 Additional Information

Device is powered by 3.3 VDC. Bluetooth and WLAN operate at frequency range 2.4 – 2.4835 GHz.

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3 REFERENCES

Publication	Edition	Date	AMD 1	AMD 2
IEC 62311	2	2019	-	-
IEC 62232	2	2017	-	-
ICNIRP	-	2020	-	-

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
CISPR 16-4-1
CISPR 16-4-2
CISPR 32
ANSI C63.23
A2LA P103
A2LA P103c
ETSI TR 100-028

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 RF EXPOSURE EVALUATION

5.1 Limits

The device shall comply with the relevant limits for Equivalent plane wave power density for the general public, as stated by ICNIRP in the table below.

ICNIRP Guidelines • ICNIRP

Table 5. Reference levels for exposure, averaged over 30 min and the whole body, to electromagnetic fields from 100 kHz to 300 GHz (unperturbed rms values).^a

Exposure scenario	Frequency range	Incident E-field strength; E_{inc} ($V\ m^{-1}$)	Incident H-field strength; H_{inc} ($A\ m^{-1}$)	Incident power density; S_{inc} ($W\ m^{-2}$)
Occupational	0.1 – 30 MHz	$660/f_M^{0.7}$	$4.9/f_M$	NA
	>30 – 400 MHz	61	0.16	10
	>400 – 2000 MHz	$3f_M^{0.5}$	$0.008f_M^{0.5}$	$f_M/40$
	>2 – 300 GHz	NA	NA	50
General public	0.1 – 30 MHz	$300/f_M^{0.7}$	$2.2/f_M$	NA
	>30 – 400 MHz	27.7	0.073	2
	>400 – 2000 MHz	$1.375f_M^{0.5}$	$0.0037f_M^{0.5}$	$f_M/200$
	>2 – 300 GHz	NA	NA	10

^aNote:

1. "NA" signifies "not applicable" and does not need to be taken into account when determining compliance.
2. f_M is frequency in MHz.
3. S_{inc} , E_{inc} , and H_{inc} are to be averaged over 30 min, over the whole-body space. Temporal and spatial averaging of each of E_{inc} and H_{inc} must be conducted by averaging over the relevant square values (see eqn 8 in Appendix A for details).
4. For frequencies of 100 kHz to 30 MHz, regardless of the far-field/near-field zone distinctions, compliance is demonstrated if neither E_{inc} or H_{inc} exceeds the above reference level values.
5. For frequencies of >30 MHz to 2 GHz: (a) within the far-field zone: compliance is demonstrated if either S_{inc} , E_{inc} , or H_{inc} , does not exceed the above reference level values (only one is required); S_{eq} may be substituted for S_{inc} ; (b) within the radiative near-field zone, compliance is demonstrated if either S_{inc} , or both E_{inc} and H_{inc} , does not exceed the above reference level values; and (c) within the reactive near-field zone: compliance is demonstrated if both E_{inc} and H_{inc} do not exceed the above reference level values; S_{inc} cannot be used to demonstrate compliance, and so basic restrictions must be assessed.
6. For frequencies of >2 GHz to 300 GHz: (a) within the far-field zone: compliance is demonstrated if S_{inc} does not exceed the above reference level values; S_{eq} may be substituted for S_{inc} ; (b) within the radiative near-field zone, compliance is demonstrated if S_{inc} does not exceed the above reference level values; and (c) within the reactive near-field zone, reference levels cannot be used to determine compliance, and so basic restrictions must be assessed.

Figure 1: Radio Frequency reference levels from ICNIRP guidelines

Bluetooth/WLAN (2.4 – 2.4835 GHz) Limit = 10 W/m²

5.2 Spherical Evaluation Formula for Far-Field

B.4.2.1.1.2 Applicability of spherical formulas

The far-field spherical formulas can be used to evaluate the spatial-peak and spatially-averaged RF field strengths. The spatially-averaged and spatial-peak equivalent power densities can be evaluated as follows:

$$S = \frac{\bar{P}_{\text{net}} G_{\theta, \phi}}{4\pi r^2} \quad (\text{B.15})$$

Figure 2: Spherical formula to calculate power density from IEC 62232

S = Power density (W/m²)

P = Conducted power output (W)

G = Antenna gain

r = distance to center of radiating antenna (m)

5.3 Evaluation Results

Maximum Power = Measured value (dBm) + Antenna Gain (dBd) + Tune Up Tolerance (dB)
Tune up Tolerance is accounted for on the spectrum analyzer

a. WLAN

Maximum Conducted Power as referenced by report TR316051

WLAN

802.11b: P = 19.5 dBm EIRP (at 85°C)

802.11g: P = 17 dBm EIRP (at 22.2°C)

802.11n HT20: P = 16.0 dBm EIRP (at 22.2°C)

Figure 3: WLAN maximum RF power with antenna gain already factored in from test report TR316051

$$P = 17.5 \text{ dBm} = 0.056 \text{ W}$$

$$G = 2.00 \text{ dBi} = 1.58$$

$$S = (0.056 * 1.58) / (4 * \pi * 0.2^2) = 0.18 \text{ W/m}^2$$

Ant. No.	Model	Type	Connector	Operating Frequencies (MHz) / Antenna Gain (dBi)
				863-870
1	Laird 001-0001	Dipole	RP-SMA	2.0
2	Laird 001-0014	FlexPIFA	IPEX MHF5I	2.0
3	Laird 001-0015	FlexNotch	IPEX MHF5I	2.0
4	-	Chip	PCB	1.5

Table 1: List of WLAN antenna(s) used with LWB

b. Bluetooth Low Energy

Maximum power as reference by report TR316051

$$P = 7.4 \text{ dBm} = 5.5 \text{ mW}$$

$$G = 2.0 \text{ dBi} = 1.58$$

$$S = (0.0055 * 1.58) / (4 * \pi * 0.2^2) = 0.017 \text{ W/m}^2$$

BLE

P = 9.4 dBm EIRP (at -40°C)

Figure 4: Bluetooth maximum RF power with antenna gain already factored in from test report TR316051

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Ant. No.	Model	Type	Connector	Operating Frequencies (MHz) / Antenna Gain (dBi)
				863-870
1	Laird 001-0001	Dipole	RP-SMA	2.0
2	Laird 001-0014	FlexPIFA	IPEX MHF5I	2.0
3	Laird 001-0015	FlexNotch	IPEX MHF5I	2.0
4	-	Chip	PCB	1.5

Table 2: List of Bluetooth antenna(s) used with LWB

c. Total Power Density

$$S_T(x, y, z) = \sum_{k=1}^N S_k(x, y, z)$$

Figure 5: Total power density equation

$$S = 0.18 + 0.017 = 0.20 \text{ W/m}^2$$

Since the power density at 20 cm is less than the reference level, the unit meets the requirements of IEC 62311.

d. Minimum Distance

Minimum distance away from the device to meet the reference level requirement for incident power density (ICNIRP).

$$10.0 \text{ W/m}^2 = 0.20 \text{ W} / (4 * \pi * r^2)$$

$$r = 0.04 \text{ m}$$

The EUT meets the requirements of IEC 62311 for all r values greater than 4.0 cm.

6 REVISION HISTORY

Version	Date	Notes	Person
0	12/16/2022	First Draft	Dylan Rosenfeldt

END OF REPORT