

Test Report # 3434 B

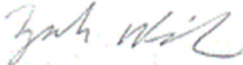
Equipment Under Test: Sterling LWB

Requirement(s): FCC 15.247, RSS-247, FCC 15.209, RSS-GEN
(Bluetooth Classic, FHSS, Class 2 Permissive Change)

Test Date(s): July 22nd, 2021 to August 19th, 2021

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

Report Issued by: Zach Wilson, EMC Engineer

Signature: 

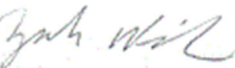
Date: 11/10/2021

Report Reviewed by: Adam Alger, Laboratory Manager

Signature: 

Date: 8/23/2021

Report Constructed by: Zach Wilson, EMC Engineer

Signature: 

Date: 8/19/2021

This test report may not be reproduced, except in full, without approval of Laird Connectivity, Inc.

CONTENTS

Contents	2
Laird Connectivity Test Services in Review	3
1 Test Report Summary	4
2 Client Information	5
2.1 Equipment Under Test (EUT) Information	5
2.2 Product Description	5
2.3 Modifications Incorporated for Compliance.....	5
2.4 Deviations and Exclusions from Test Specifications	5
2.5 Programming Information	5
2.6 Antenna Information	5
2.7 Channels and Data Rates/Modulations	6
3 References	7
4 Uncertainty Summary	8
5 Test Data	9
5.1 Antenna Port Conducted Emissions.....	9
5.2 Radiated Emissions	14
6 Revision History	19

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:



Certificate #1255.01

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



**Government
of Canada**

Innovation, Science and Economic Development Canada

Accredited U.S. Identification Number: US0218

Recognition of two 3 meter Semi-Anechoic Chambers

Company: Laird Connectivity, Inc.	Page 3 of 19	Name: Sterling LWB
Report: TR3434 B		Model: Sterling LWB
Job: C-3434		Serial: Engineering Sample

1 TEST REPORT SUMMARY

During **July 22nd, 2021 to August 19th, 2021** the Equipment Under Test (EUT), **Sterling LWB**, as provided by **Laird Connectivity, Inc.** was tested to the following requirements of the **Federal Communications Commission** and **Innovation, Science and Economic Development Canada**:

FCC 15.247 / RSS-247 FHSS

Requirement	Description	Specification	Method	Result
FCC: 15.247 (b)(1) IC: RSS-247 5.4 (b)	Maximum Conducted Output Power	30 dBm	ANSI C63.10	Compliant
FCC: 15.247 (d) IC: RSS-GEN 8.10	Spurious Radiated Emissions in Restricted Bands	FCC 15.209 RSS-GEN 8.9	ANSI C63.10	Compliant

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, Inc.
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

Laird 2.4 GHz WLAN and BT/BLE radio module. Radios cannot transmit simultaneously.
The PCB trace width has been altered from the original filing.

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 Programming Information

The Bluetooth radio was programmed using CyBluetool v0.1.55.1.

2.6 Antenna Information

Johanson Technology high frequency ceramic chip antenna, part number 2450AT18D0100. The chip antenna has a peak gain of 1.5dBi.

2.7 Channels and Data Rates/Modulations

Bluetooth Classic Channels: 0 (2402 MHz), 39 (2440 MHz), 79 (2480 MHz)

Bluetooth Classic Data Rate/Modulations: GFSK 1Mbps BR, QPSK 2Mbps EDR2, 8PSK 3Mbps EDR3

3 REFERENCES

Publication	Edition	Date	AMD 1	AMD 2
FCC eCFR	-	2021	-	-
RSS-247	2	2017	-	-
RSS-GEN	5	2018	2019	2021
ANSI C63.10	-	2013	-	-
KDB 996369 D04	01	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

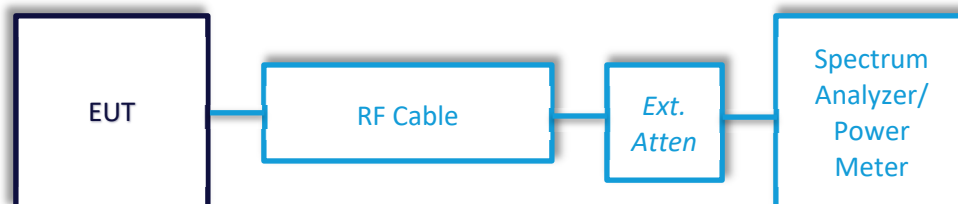
Parameter	ETSI U.C. $\pm$	U.C. $\pm$
Radio Frequency, from F0	1×10^{-7}	0.55×10^{-7}
Occupied Channel Bandwidth	5 %	2 %
RF conducted Power (Power Meter)	1.5 dB	1.2 dB
RF conducted emissions (Spectrum Analyzer)	3.0 dB	1.7 dB
All emissions, radiated	6.0 dB	5.3 dB
Temperature	1° C	0.65° C
Humidity	5 %	2.9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



5.1.1 Peak Fundamental Emission Output Power – Bluetooth Classic

Operator	Anthony Smith	QA	Zach Wilson
Temperature	22°C	R.H. %	52.10%
Test Date	8/19/2021	Location	Conducted RF Bench
Requirement	FCC 15.247, RSS-247	Method	ANSI C63.10 §7.8.5

Limits: 30 dBm / 1 Watt

Test Parameters

Frequency	2402 MHz, 2440 MHz, 2480 MHz	Setup	Conducted
Detector(s)	Peak, Max Hold	RBW	1 MHz (GFSK) 3 MHz (QPSK, 8PSK)
VBW	3 MHz (GFSK) 8 MHz (QPSK, 8PSK)	Span	5 MHz

Instrumentation

No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	EE 960087	Analyzer - Spectrum	Agilent	N9010A	MY53400296	4/21/2021	4/21/2022	Active Calibration
2	AA 960172	Cable	A.H. Systems, Inc	SAC-26G-1	387	4/19/2021	4/19/2022	Active Calibration

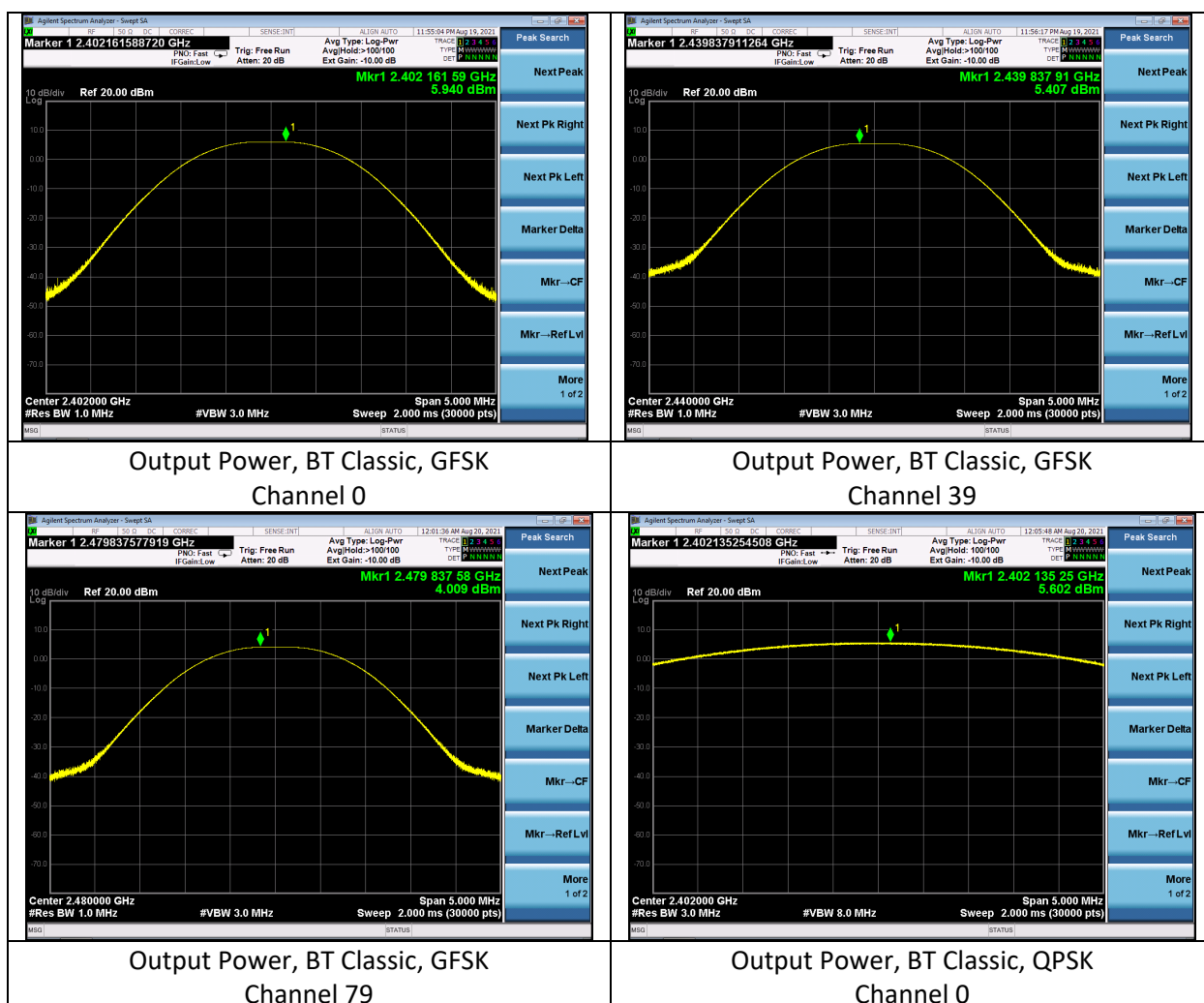
EUT Parameters

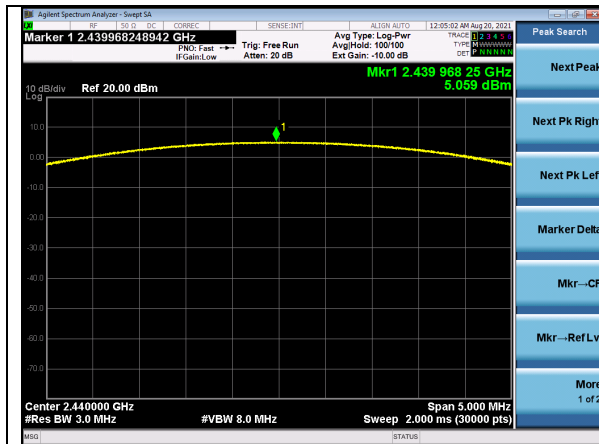
Input Power	3.7VDC	Mode	BTC Modulated Transmit, Single Channel
Frequency	2402-2480 MHz	Channel	0, 39, 79
Data Rates/Mods	GFSK 1Mbps BR QPSK 2Mbps EDR2 8PSK 3Mbps EDR3		

Data Table

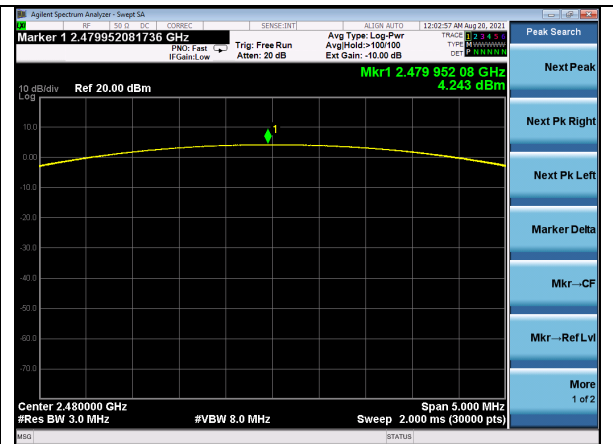
Channel	Radio Mode	Peak Output Power (dBm)	Limit (dBm)	Margin (dB)
0	GFSK	5.9	30.0	24.1
39	GFSK	5.4	30.0	24.6
79	GFSK	4.0	30.0	26.0
0	QPSK	5.6	30.0	24.4
39	QPSK	5.1	30.0	24.9
79	QPSK	4.2	30.0	25.8
0	8PSK	6.1	30.0	23.9
39	8PSK	5.5	30.0	24.5
79	8PSK	4.5	30.0	25.5

Plots

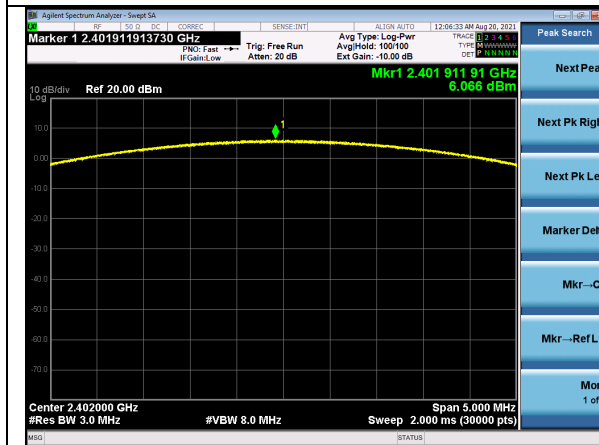




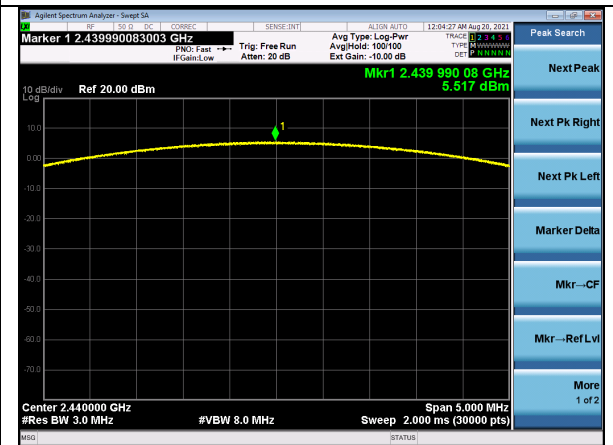
Output Power, BT Classic, QPSK
Channel 39



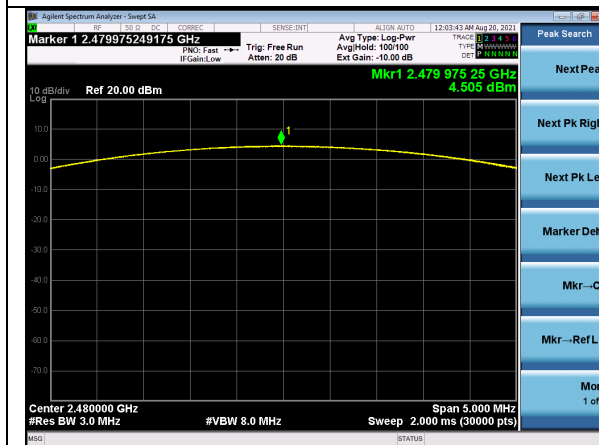
Output Power, BT Classic, QPSK
Channel 79



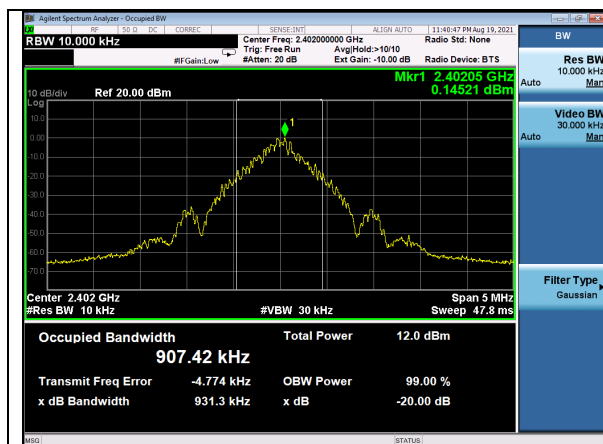
Output Power, BT Classic, QPSK
Channel 0



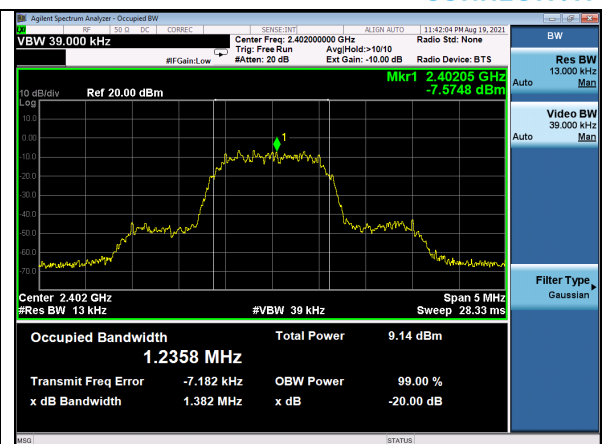
Output Power, BT Classic, 8PSK
Channel 39



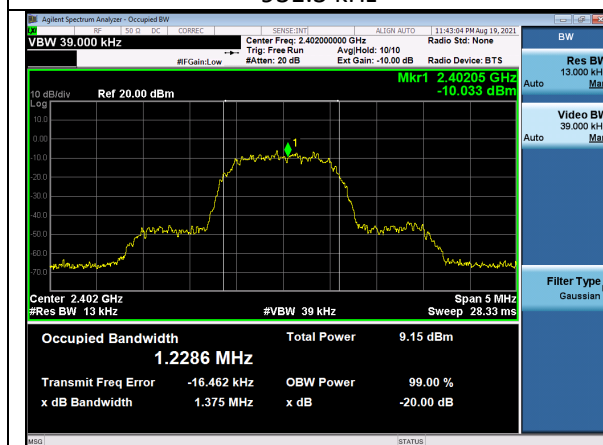
Output Power, BT Classic, 8PSK
Channel 79



20dB Bandwidth, BT Classic, GFSK
931.3 kHz



20dB Bandwidth, BT Classic, QPSK
1.382 MHz



20dB Bandwidth, BT Classic, 8PSK
1.375 MHz

5.2 Radiated Emissions

Description of Measurement	The frequency spectrum is investigated for intentional and / or unintentional signals emanating from the EUT by use of a standardized test site and measurement antenna. The antenna, cable, pre-amp, and other necessary measurement system correction factors are loaded onto the EMI receiver / spectrum analyzer when the measurements are performed allowing the data to be gathered and reported as corrected values. The maximum emissions from the EUT are determined by turn-table azimuth rotation (360°) and scanning of the measurement antenna. Maximized levels are noted at degree values of azimuth, measurement antenna height, and measurement antenna polarity.
Example Calculations	Measurement (dBμV) + Cable factor (dB) + Other (dB) + Antenna Factor (dB/m) = Corrected Reading (dBμV/m) Margin (dB) = Limit (dBμV/m) - Corrected Reading (dBμV/m) Example at 4000 MHz: Reading = 40 dBμV + 3.4 dB + 0.9 dB + 6.5 dB/m = 50.8 dBμV/m Average Limit = 20 log (500) = 54 dBμV/m Margin = 54 dBμV/m - 50.8 dBμV/m = 3.2 dB

Block Diagram



5.2.1 Radiated Emissions – Bluetooth Classic

Operator	Ivan Alvarez, Braden Smith, Anthony Smith	QA	Anthony Smith, Jon Dilley, Adam Alger
Temperature	23.3C	R.H. %	51.40%
Test Date	7/22/2021, 8/12/2021, 8/13/2021	Location	Chambers 3 and 5
Requirement	FCC 15.247, RSS-247, FCC 15.209, RSS-GEN	Method	ANSI C63.10

Limits:

Peak: 74 dBμV/m

Average: 54 dBμV/m

Test Parameters

Frequency	2310-2390 MHz 2483.5-2500 MHz 4-25 GHz	Distance	3m
Detector(s)	Peak max hold for plots. Average measurements taken with a VBW of 30 Hz.	Table height	150cm
RBW	1 MHz	VBW	30 kHz for locating emissions 300 kHz for average 3 MHz for peak
Notes	Hopping and single channel used for band edges. Single channel used for harmonics.		

Instrumentation

No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	AA 960158	Antenna - Double Ridge Horn	ETS Lindgren	3117	109300	12/7/2020	12/7/2021	Active Calibration
2	AA 960154	Filter - High Pass 2.4 GHz	KWM	HPF-L-14186	7272-02	4/21/2021	4/21/2022	Active Calibration
3	AA 960176	Cable	A.H. Systems, Inc	SAC-26G-6	395	3/3/2021	7/24/2022	Active Calibration
4	EE 960085	Analyzer - EMI Receiver	Agilent	N9038A	MY51210148	5/14/2021	5/14/2022	Active Calibration
5	EE960196	Meter - Hygro-Thermometer	Control Company	90080-03	180045462	5/14/2021	5/14/2021	Active Calibration
6	EE 960203	Analyzer - EMI Receiver	Keysight	N9038A	MY56400072	4/20/2021	4/20/2022	Active Calibration
7	LSC-500	Cable	Chamber 5 Emiss -	-	-	9/14/2020	9/14/2021	Active Calibration
8	AA 960081	Antenna - Double Ridge Horn	EMCO	3115	6907	10/29/2020	10/29/2021	Active Calibration
9	EE 960159	Antenna - Low Noise Amplifier	Mini-Circuits	ZVA-213X-S+	691801732	12/7/2020	12/7/2021	Active Calibration

Company: Laird Connectivity, Inc.	Page 15 of 19	Name: Sterling LWB
Report: TR3434 B		Model: Sterling LWB
Job: C-3434		Serial: Engineering Sample

EUT Parameters

Input Power	3.7VDC	Mode	BTC Modulated Transmit, Hopping, Single Channel
Channels	0, 39, 79, Hopping	Data Rates/Modulations	GFSK, QPSK, 8PSK, Hopping (Band Edges) GFSK (Harmonics)

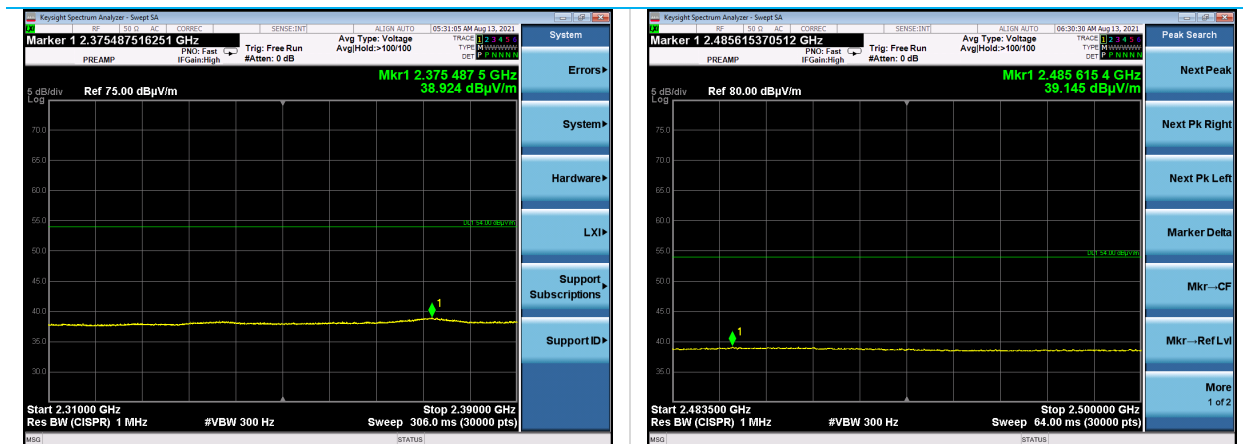
Data Tables

Frequency (MHz)	Antenna Polarity	Height (cm)	Azimuth (degree)	Average Reading (dBμV/m)	Average Limit (dBμV/m)	Average Margin (dB)	Channel/Data Rate
2375.6	Horizontal	210	157	39.0	54.0	15.0	Hopping
2487.8	Horizontal	210	157	39.2	54.0	14.8	Hopping
2375.5	Horizontal	210	157	38.9	54.0	15.1	0, GFSK
2485.6	Horizontal	210	157	39.1	54.0	14.9	79, GFSK
2375.2	Horizontal	210	157	39.0	54.0	15.0	0, QPSK
2486.7	Horizontal	210	157	39.2	54.0	14.8	79, QPSK
2375.7	Horizontal	210	157	39.1	54.0	14.9	0, 8PSK
2487.5	Horizontal	210	157	39.1	54.0	14.9	79, 8PSK

Frequency (MHz)	Antenna Polarity	Height (cm)	Azimuth (degree)	Peak Reading (dBμV/m)	Peak Limit (dBμV/m)	Peak Margin (dB)	Channel/Data Rate
2375.6	Horizontal	210	157	48.6	74.0	25.4	Hopping
2487.8	Horizontal	210	157	49.4	74.0	24.6	Hopping
2375.5	Horizontal	210	157	49.3	74.0	24.7	0, GFSK
2485.6	Horizontal	210	157	49.8	74.0	24.2	79, GFSK
2375.2	Horizontal	210	157	49.8	74.0	24.2	0, QPSK
2486.7	Horizontal	210	157	50.0	74.0	24.0	79, QPSK
2375.7	Horizontal	210	157	49.7	74.0	24.3	0, 8PSK
2487.5	Horizontal	210	157	49.8	74.0	24.2	79, 8PSK

Frequency (MHz)	Antenna Polarity	Height (cm)	Azimuth (degree)	Peak Reading (dBμV/m)	Peak Limit (dBμV/m)	Peak Margin (dB)	Average Reading (dBμV/m)	Average Limit (dBμV/m)	Average Margin (dB)	Channel/Data Rate
17083.4	Vertical	150	0	50.0	74.0	24.0	44.1	54.0	9.9	BTC GFSK 39
17094.7	Horizontal	150	0	50.1	74.0	24.0	43.5	54.0	10.5	BTC GFSK 39
170761.8	Horizontal	150	0	48.9	74.0	25.1	41.0	54.0	13.0	BTC GFSK 39
17905.7	Vertical	150	0	49.9	74.0	24.1	44.0	54.0	10.0	BTC GFSK 39
16810.8	Horizontal	150	0	49.0	74.0	25.0	40.5	54.0	13.5	BTC GFSK 39
170716.6	Vertical	150	0	49.8	74.0	24.2	40.4	54.0	13.6	BTC GFSK 39

Plots



2310-2390 MHz, Horizontal Antenna, Average
GFSK, Channel 0

2483.5-2500 MHz, Horizontal Antenna, Average
GFSK, Channel 79



2310-2390 MHz, Horizontal Antenna, Average
QPSK, Channel 0

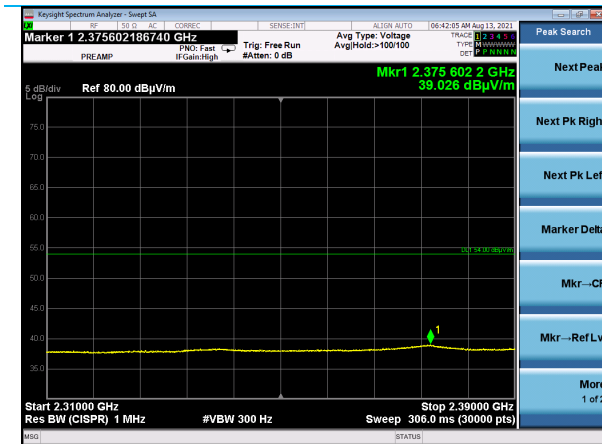
2483.5-2500 MHz, Horizontal Antenna, Average
QPSK, Channel 79



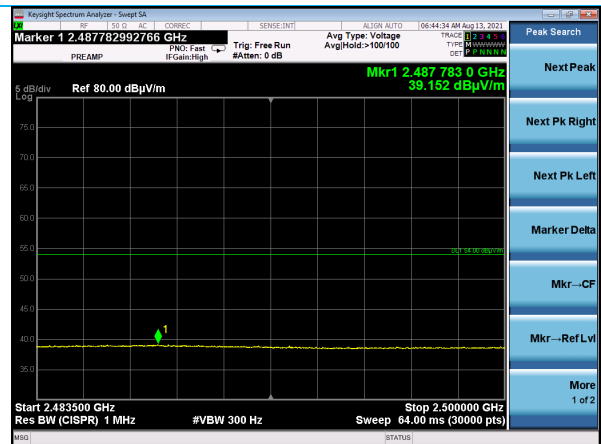
2310-2390 MHz, Horizontal Antenna, Average
8PSK, Channel 0

2483.5-2500 MHz, Horizontal Antenna, Average
8PSK, Channel 79

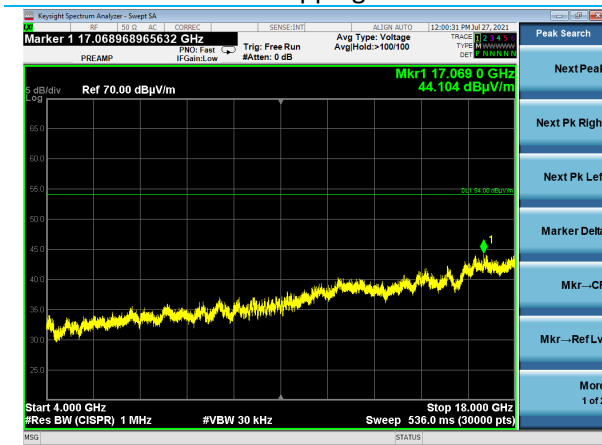
Company: Laird Connectivity, Inc.		Name: Sterling LWB
Report: TR3434 B	Page 17 of 19	Model: Sterling LWB
Job: C-3434		Serial: Engineering Sample



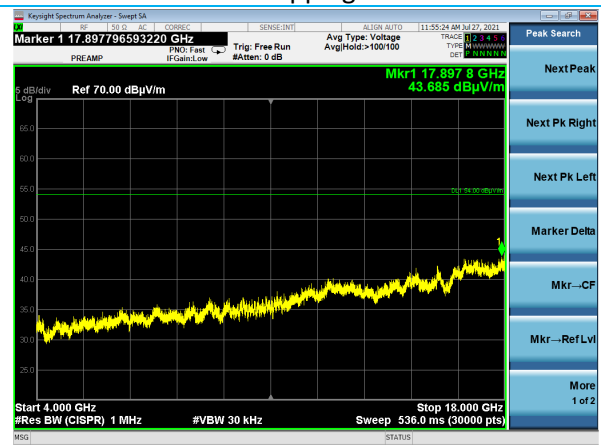
2310-2390 MHz, Horizontal Antenna, Average Hopping



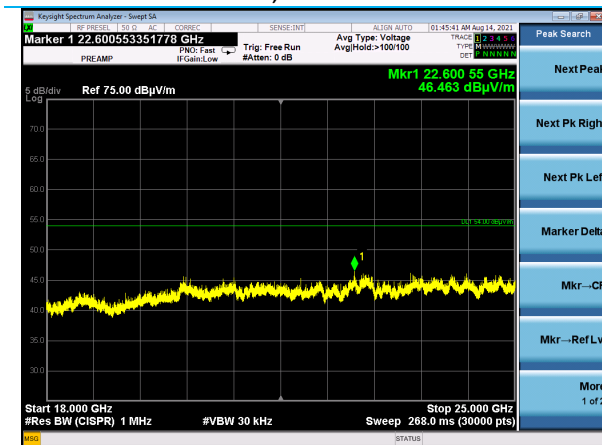
2483.5-2500 MHz, Horizontal Antenna, Average Hopping



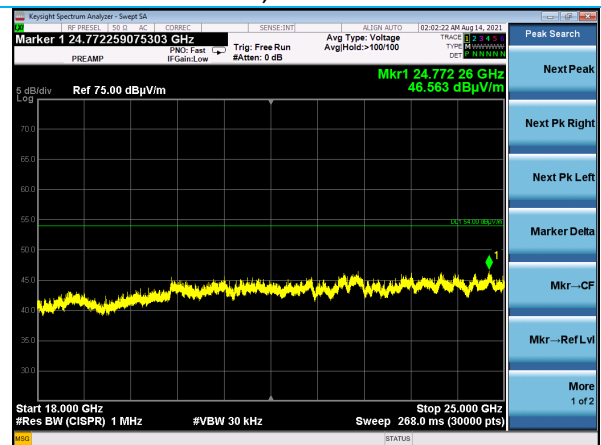
4-18 GHz, Horizontal Antenna GFSK, Channel 39



4-18 GHz, Vertical Antenna GFSK, Channel 39



18-25 GHz, Horizontal Antenna GFSK, Channel 39



18-25 GHz, Vertical Antenna GFSK, Channel 39

6 REVISION HISTORY

Version	Date	Notes	Person
0	8/19/2021	Initial Draft	Zach Wilson
1	8/23/2021	Retest of conducted output power with EMI receiver method.	Zach Wilson

END OF REPORT