

Test Report # 3560 C

Equipment Under Test:	OD1025-01
Requirement(s):	FCC Part 1.1307, 2.1091, 2.1093 ISED RSS-102
Test Date(s):	March 9 th , 2022
Prepared for:	Enovation Controls, LLC Attn: Jim Fox 5311 South 122 nd East Avenue Tulsa, OK 74146

Report Issued by: Zach Wilson, EMC Engineer

Signature: 

Date: 6/23/2022

Report Reviewed by: Adam Alger, Laboratory Manager

Signature: 

Date: 6/16/2022

Report Constructed by: Zach Wilson, EMC Engineer II

Signature: 

Date: 6/15/2022

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Company: Enovation Controls, LLC	Page 1 of 17	Name: OD1025-01
Report: TR3560 C		Model: OD1025-01
Quote: NBO-09-2021-004132-1		Serial: Engineering Sample

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 Antenna Information	6
3 References	7
4 Uncertainty Summary	8
5 rf output power.....	9
6 FCC RF Exposure Evaluation – Single Transmitter	10
7 FCC RF Exposure Evaluation – Simultaneous Transmitters	12
8 ISED RF Exposure Evaluation – Single Transmitter	14
9 ISED RF Exposure Evaluation – Simultaneous Transmitters	16
10 Revision History	17

Company: Enovation Controls, LLC	Page 2 of 17	Name: OD1025-01
Report: TR3560 C		Model: OD1025-01
Quote: NBO-09-2021-004132-1		Serial: Engineering Sample

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

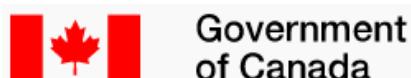
Scope of accreditation includes all test methods listed herein unless otherwise noted



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: Enovation Controls, LLC		Name: OD1025-01
Report: TR3560 C	Page 3 of 17	Model: OD1025-01
Quote: NBO-09-2021-004132-1		Serial: Engineering Sample

1 TEST REPORT SUMMARY

On **March 9th, 2022**, the Equipment Under Test (EUT), **OD1025-01**, as provided by **Enovation Controls, LLC** was tested to the following requirements of the **Federal Communications Commission and Innovation, Science and Economic Development Canada**:

Requirement	Description	Specification	Method	Result
FCC Part 1.1307, 2.1091, 2.1093	RF Exposure and equipment authorization requirements	Reported	FCC KDB 447498	Compliant
ISED Canada RSS-102	Radio Frequency Radiation Exposure Evaluation	Reported	RSS-102 Section 2.5.1	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 the specified limit
Emissions – Frequency	1% less than the specification

Company: Enovation Controls, LLC	Page 4 of 17	Name: OD1025-01
Report: TR3560 C		Model: OD1025-01
Quote: NBO-09-2021-004132-1		Serial: Engineering Sample

2 CLIENT INFORMATION

Company Name	Enovation Controls, LLC
Contact Person	Jim Fox
Address	5311 S. 122 nd E. Avenue Tulsa, OK 74146

2.1 Equipment Under Test (EUT) Information

The following information has been supplied by the client

Product Name	OD1025-01
Model Number	OD1025-01
Serial Number	Engineering Sample
FCC ID	2A3FV-ECB01
ISED ID	28102-ECB01

2.2 Product Description

The EUT contains three Laird Connectivity BT850 BLE/BT modules. Each module contains a different trace layout. All BT/BLE modules use the chip antenna listed in section 2.5. Device powered at 14 VDC.

The EUT also contains the Texas Instruments WL18MODGI, FCC ID: Z64-WL18DBMOD, IC ID: 451I-WL18DBMOD. The module is capable of WLAN 2.4 and WLAN 5 GHz.

The following configurations can be used for simultaneous transmission:

WLAN 2.4 GHz + (3) BT/BLE

WLAN 5 GHz + (3) BT/BLE

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

Company: Enovation Controls, LLC	Page 5 of 17	Name: OD1025-01
Report: TR3560 C		Model: OD1025-01
Quote: NBO-09-2021-004132-1		Serial: Engineering Sample

2.5 Antenna Information

BT/BLE: Johanson Chip Antenna (QTY 3), P/N: 2450AT18D0100, with a peak gain of 1.5 dBi.

WLAN: Pulse, P/N: W3006, Dual band chip antenna with a peak gain of 3.2dBi in the 2.4GHz band and a peak gain of 4.2dB in the 5GHz band.

2.6 Power Setting

All radios tested at maximum output power per radio firmware.

Company: Enovation Controls, LLC	Page 6 of 17	Name: OD1025-01
Report: TR3560 C		Model: OD1025-01
Quote: NBO-09-2021-004132-1		Serial: Engineering Sample

3 REFERENCES

Publication	Edition	Date
CFR 47 Part 15	-	2021
ANSI C63.10	-	2013
RSS-247	2	2017
RSS GEN	5	2014
RSS-102	5	2015
CFR 47 Part 1 and 2	-	2021
FCC KDB 447498	D04 v01	2021
Notice 2016-DRS001	-	2020

Company: Enovation Controls, LLC	Page 7 of 17	Name: OD1025-01
Report: TR3560 C		Model: OD1025-01
Quote: NBO-09-2021-004132-1		Serial: Engineering Sample

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 %

Company: Enovation Controls, LLC	Page 8 of 17	Name: OD1025-01
Report: TR3560 C		Model: OD1025-01
Quote: NBO-09-2021-004132-1		Serial: Engineering Sample

5 RF OUTPUT POWER

All output power values, antenna gains, and tune-up tolerances have been provided by the client.

Bluetooth Classic Maximum Output Power

Frequency (MHz)	Output Power (dBm)	Antenna Gain (dBi)	Tune-up Tolerance (dB)
2440.0	8.8	1.5	1.0

Bluetooth Low Energy Maximum Output Power

Frequency (MHz)	Output Power (dBm)	Antenna Gain (dBi)	Tune-up Tolerance (dB)
2440.0	8.0	1.5	1.0

WLAN 2.4 GHz Maximum Output Power

Frequency (MHz)	Output Power (dBm)	Antenna Gain (dBi)	Tune-up Tolerance (dB)
2437.0	20.6	3.2	1.0

WLAN 5 GHz Maximum Output Power

Frequency (MHz)	Output Power (dBm)	Antenna Gain (dBi)	Tune-up Tolerance (dB)
5500.0	18.5	4.2	1.0

Company: Enovation Controls, LLC	Page 9 of 17	Name: OD1025-01
Report: TR3560 C		Model: OD1025-01
Quote: NBO-09-2021-004132-1		Serial: Engineering Sample

6 FCC RF EXPOSURE EVALUATION – SINGLE TRANSMITTER

FCC Single Transmitter – Bluetooth Classic

Frequency (MHz)	Conducted Output Power (dBm)	Tune Up Tolerance (dBm)	Corrected Output Power (mW)	MPE Distance (cm)
2440	8.8	1.0	9.6	20

Frequency (GHz)	Wavelength	$\lambda/2\pi$	Distance (m)	Distance (cm)	Distance (mm)	MPE Exemption Limit (W)	MPE Exemption Limit (mW)
2.440E+09	0.12295	0.0196	0.21	21	210	0.84672	846.7

Result: EUT power of 9.6 mW is less than the MPE exclusion threshold of 846.7 mW at the minimum distance of 21 cm.

FCC Single Transmitter – Bluetooth Low Energy

Frequency (MHz)	Conducted Output Power (dBm)	Tune Up Tolerance (dBm)	Corrected Output Power (mW)	MPE Distance (cm)
2440	8.0	1.0	8.0	20

Frequency (GHz)	Wavelength	$\lambda/2\pi$	Distance (m)	Distance (cm)	Distance (mm)	MPE Exemption Limit (W)	MPE Exemption Limit (mW)
2.440E+09	0.12295	0.0196	0.21	21	210	0.84672	846.7

Result: EUT power of 8.0 mW is less than the MPE exclusion threshold of 846.7 mW at the minimum distance of 21 cm.

Company: Enovation Controls, LLC	Page 10 of 17	Name: OD1025-01
Report: TR3560 C		Model: OD1025-01
Quote: NBO-09-2021-004132-1		Serial: Engineering Sample

FCC Single Transmitter – WLAN 2.4 GHz

Frequency (MHz)	Conducted Output Power (dBm)	Antenna Gain (dBi)	Tune Up Tolerance (dBm)	Corrected Output Power (dBm)	Corrected Output Power (mW)	MPE Distance (cm)
5500	20.6	3.2	1.0	24.8	302.0	21

Frequency (GHz)	Wavelength	$\lambda/2\pi$	Distance (m)	Distance (cm)	Distance (mm)	MPE Exemption Limit (W)	MPE Exemption Limit (mW)
2.437E+09	0.12310	0.0196	0.21	21	210	0.84672	846.7

Result: EUT power of 302.0 mW is less than the MPE exclusion threshold of 846.7 mW at the minimum distance of 21 cm.

FCC Single Transmitter – WLAN 5 GHz

Frequency (MHz)	Conducted Output Power (dBm)	Antenna Gain (dBi)	Tune Up Tolerance (dBm)	Corrected Output Power (mW)	Corrected Output Power (mW)	MPE Distance (cm)
5500.0	18.5	4.2	1.0	23.7	234.4	21

Frequency (GHz)	Wavelength	$\lambda/2\pi$	Distance (m)	Distance (cm)	Distance (mm)	MPE Exemption Limit (W)	MPE Exemption Limit (mW)
5.50E+09	0.05455	0.0087	0.21	21	210	0.84672	846.7

Result: EUT power of 234.4 mW is less than the MPE exclusion threshold of 846.7 mW at the minimum distance of 21 cm.

Company: Enovation Controls, LLC	Page 11 of 17	Name: OD1025-01
Report: TR3560 C		Model: OD1025-01
Quote: NBO-09-2021-004132-1		Serial: Engineering Sample

7 FCC RF EXPOSURE EVALUATION – SIMULTANEOUS TRANSMITTERS

FCC Simultaneous Transmission

Equation used from KDB 447498 D04 Interim General RF Exposure Guidance v01, Appendix C

$$\sum_{i=1}^a \frac{P_i}{P_{th,i}} + \sum_{j=1}^b \frac{ERP_j}{ERP_{th,j}} + \sum_{k=1}^c \frac{Evaluated_k}{Exposure\ Limit_k} \leq 1 \quad (C.1)$$

- a* number of fixed, mobile, or portable RF sources claiming exemption using the § 1.1307(b)(3)(i)(B) formula for P_{th} , including existing exempt transmitters and those being added.
- b* number of fixed, mobile, or portable RF sources claiming exemption using the applicable § 1.1307(b)(3)(i)(C) Table 1 formula for Threshold ERP, including existing exempt transmitters and those being added.
- c* number of existing fixed, mobile, or portable RF sources with known evaluation for the specified minimum distance.
- P_i the available maximum time-averaged power or the ERP, whichever is greater, for fixed, mobile, or portable RF source *i* at a distance between 0.5 cm and 40 cm (inclusive).
- $P_{th,i}$ the exemption threshold power (P_{th}) according to the § 1.1307(b)(3)(i)(B) formula for fixed, mobile, or portable RF source *i*.
- ERP_j the available maximum time-averaged power or the ERP, whichever is greater, of fixed, mobile, or portable RF source *j*.
- $ERP_{th,j}$ exemption threshold ERP for fixed, mobile, or portable RF source *j*, at a distance of at least $\lambda/2\pi$, according to the applicable § 1.1307(b)(3)(i)(C) Table 1 formula at the location in question.
- $Evaluated_k$ the maximum reported SAR or MPE of fixed, mobile, or portable RF source *k* either in the device or at the transmitter site from an existing evaluation.
- $Exposure\ Limit_k$ either the general population/uncontrolled maximum permissible exposure (MPE) or specific absorption rate (SAR) limit for each fixed, mobile, or portable sources, as applicable

Company: Enovation Controls, LLC	Page 12 of 17	Name: OD1025-01
Report: TR3560 C		Model: OD1025-01
Quote: NBO-09-2021-004132-1		Serial: Engineering Sample

BT Classic radios (qty 3) in simultaneous transmission with WLAN 2.4 GHz radio.

$$\sum_{i=1}^3 \frac{9.6 \text{mW}}{846.7 \text{mW}} + \sum_{i=1}^1 \frac{302.0 \text{mW}}{846.7 \text{mW}} = 0.391$$

Result

0.391 < 1. The device in simultaneous transmission as shown in the above configuration is exempt from further evaluation.

BT Classic radios (qty 3) in simultaneous transmission with WLAN 5 GHz radio.

$$\sum_{i=1}^3 \frac{9.6 \text{mW}}{846.7 \text{mW}} + \sum_{i=1}^1 \frac{234.4 \text{mW}}{846.7 \text{mW}} = 0.311$$

Result

0.311 < 1. The device in simultaneous transmission as shown in the above configuration is exempt from further evaluation.

Company: Enovation Controls, LLC	Page 13 of 17	Name: OD1025-01
Report: TR3560 C		Model: OD1025-01
Quote: NBO-09-2021-004132-1		Serial: Engineering Sample

8 ISED RF EXPOSURE EVALUATION – SINGLE TRANSMITTER

ISED Single Transmitter – Bluetooth Classic

Frequency (MHz)	Conducted Output Power (dBm)	Tune Up Tolerance (dBm)	Antenna Gain (dBi)	EIRP (dBm)	EIRP (mw)	SAR Test Exclusion (mW) ¹	Evaluation Distance (cm)
2440	8.8	1.0	1.5	11.3	13.5	2705.3	21

1: RSS-102 2.5.2, $[1.31 \times (10^{-2} \times f^{0.6834}W)]$, f = frequency in MHz

Result: EUT power of 13.5 mW is less than the exclusion threshold of 2705.3 mW at the minimum distance of 21 cm.

ISED Single Transmitter – Bluetooth Low Energy

Frequency (MHz)	Conducted Output Power (dBm)	Tune Up Tolerance (dBm)	Antenna Gain (dBi)	EIRP (dBm)	EIRP (mw)	SAR Test Exclusion (mw) ¹	Evaluation Distance (cm)
2440	8.0	1.0	1.5	10.5	11.3	2705.3	21

1: RSS-102 2.5.2, $[1.31 \times (10^{-2} \times f^{0.6834}W)]$, f = frequency in MHz

Result: EUT power of 11.3 mW is less than the exclusion threshold of 2705.3 mW at the minimum distance of 21 cm.

Company: Enovation Controls, LLC	Page 14 of 17	Name: OD1025-01
Report: TR3560 C		Model: OD1025-01
Quote: NBO-09-2021-004132-1		Serial: Engineering Sample

ISED Single Transmitter – WLAN 2.4 GHz

Frequency (MHz)	Conducted Output Power (dBm)	Tune Up Tolerance (dBm)	Antenna Gain (dBi)	EIRP (dBm)	EIRP (mw)	SAR Test Exclusion (mw) ¹	Evaluation Distance (cm)
2437	20.6	1.0	3.2	24.8	302.0	2703.0	21

1: RSS-102 2.5.2, $[1.31 \times (10^{-2} \times f^{0.6834}W)]$, f = frequency in MHz

Result: EUT power of 302.0 mW is less than the exclusion threshold of 2703.0 mW at the minimum distance of 21 cm.

ISED Single Transmitter – WLAN 5 GHz

Frequency (MHz)	Conducted Output Power (dBm)	Tune Up Tolerance (dBm)	Antenna Gain (dBi)	EIRP (dBm)	EIRP (mw)	SAR Test Exclusion (mw) ¹	Evaluation Distance (cm)
5500	18.5	1.0	4.2	23.7	234.5	4714.5	21

1: RSS-102 2.5.2, $[1.31 \times (10^{-2} \times f^{0.6834}W)]$, f = frequency in MHz

Result: EUT power of 234.5 mW is less than the exclusion threshold of 4714.5 mW at the minimum distance of 21 cm.

Company: Enovation Controls, LLC	Page 15 of 17	Name: OD1025-01
Report: TR3560 C		Model: OD1025-01
Quote: NBO-09-2021-004132-1		Serial: Engineering Sample

9 ISED RF EXPOSURE EVALUATION – SIMULTANEOUS TRANSMITTERS

ISED Simultaneous Transmission (Notice 2016-DRS001)

Example Equation: (Max output power (EIRP) / RSS-102 Section 2.5.2 Limit) * 100 = %
RSS-102 Section 2.5.2 Limit for 2.4 GHz is 2.7 W

Estimated RF Exposure Evaluation Calculation for three BT Classic radios simultaneously transmitting:
$$[(0.0135*3)/2.7*100]= 1.5\%$$

Estimated RF Exposure Evaluation Calculation for WLAN 2.4 MHz Radio:
$$(0.302/2.7)*100 = 11.2\%$$

Estimated RF Exposure Evaluation Calculation for WLAN 2.4 MHz Radio and three BT Classic radios simultaneously transmitting:
$$1.5+11.2 = 12.7\%$$

Result

12.7% < 100%, therefore the device in simultaneous transmissions configuration is exempt from further evaluation.

Company: Enovation Controls, LLC	Page 16 of 17	Name: OD1025-01
Report: TR3560 C		Model: OD1025-01
Quote: NBO-09-2021-004132-1		Serial: Engineering Sample

10 REVISION HISTORY

Version	Date	Notes	Person
0	5/3/2022	Initial Draft	Zach Wilson
1	5/3/2022	Revised per initial review	Zach Wilson
2	6/8/2022	Revised to include WLAN module	Zach Wilson
3	6/16/2022	Revised to 21 cm distance	Zach Wilson
4	6/23/2022	Revised per TCB comments	Zach Wilson

END OF REPORT

Company: Enovation Controls, LLC	Page 17 of 17	Name: OD1025-01
Report: TR3560 C		Model: OD1025-01
Quote: NBO-09-2021-004132-1		Serial: Engineering Sample