



## Electromagnetic Compatibility Test Report

Tests Performed on a Firefly Integrations, LLC

CAN bus to BLE and Ethernet BridgeTransceiver, Model MIRABLERVC

Radiometrics Document RP-8731



*Product Detail:*

FCC ID: 2AN2GMIRABLERVC

IC: 23328-MIRABLERVC

Equipment type: DXX

Low power transmitter FCC 15.249

*Test Standards:*

US CFR Title 47, Chapter I, FCC Part 15 Subpart C

FCC Part 15 CFR Title 47: 2017

Canada ISED; RSS-210, Issue 9: 2016 as required for Category I Equipment

This report concerns: Original Grant for Certification

*Tests Performed For:*

**Firefly Integrations, LLC**

1013 Elroy Dr.  
Middlebury, IN 46540

*Test Facility:*

**Radiometrics Midwest Corporation**

12 Devonwood Avenue  
Romeoville, IL 60446-1349  
(815) 293-0772

*Test Date(s): (Month-Day-Year)*

September 25 thru October 10, 2017

Document RP-8731 Revisions:

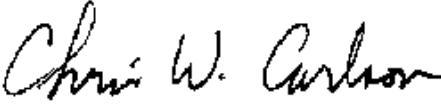
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0	November 15, 2017		
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## 1.0 ADMINISTRATIVE DATA

<i>Equipment Under Test:</i> A Firefly Integrations, CAN bus to BLE and Ethernet Bridge Model: MIRABLERVC Serial Number: none This will be referred to as the EUT in this Report	
<i>Date EUT Received at Radiometrics: (Month-Day-Year)</i> September 25, 2017	<i>Test Date(s): (Month-Day-Year)</i> September 25 thru October 10, 2017
<i>Test Report Written By:</i> Joseph Strzelecki Senior EMC Engineer	<i>Test Witnessed By:</i> The tests were not witnessed by Firefly Integrations, LLC
<i>Radiometrics' Personnel Responsible for Test:</i> 	<i>Test Report Approved By:</i> 
Joseph Strzelecki Senior EMC Engineer NARTE EMC-000877-NE	Chris W. Carlson Director of Engineering NARTE EMC-000921-NE

## 2.0 TEST SUMMARY AND RESULTS

The EUT (Equipment Under Test) is a BLE converter, Model MIRABLERVC, manufactured by Firefly Integrations, LLC. The detailed test results are presented in a separate section. The following is a summary of the test results.

### Emissions Tests Results

Environmental Phenomena	Frequency Range	Basic Standard	Test Result
RF Radiated Emissions	30-25,000 MHz	FCC Part 15.249 RSS-210 & RSS-GEN	Pass
Occupied Bandwidth Test	Fundamental Freq.	FCC Part 15 RSS-210 & RSS-GEN	Pass

No AC conducted emissions were performed, since the EUT is for installations in vehicles and will not be connected to AC mains.

Note: The RSS-210 specification is not currently covered in Radiometrics' Scope of Accreditation. This is technically very similar to FCC, CFR 47 Part 15 which is on Radiometrics scope.

### 2.1 RF Exposure Compliance Requirements

Since the power output is less than 10 mW, the EUT meets the FCC requirement for RF exposure and it is exempt from RSS-102 SAR and RF exposure evaluations. There are no power level adjustments available to the end user. The antenna is permanently attached. The detailed calculations for RF Exposure are presented in a separate document.

### 3.0 EQUIPMENT UNDER TEST (EUT) DETAILS

#### 3.1 EUT Description

The EUT is a BLE converter, Model MIRABLERVC, manufactured by Firefly Integrations, LLC. The EUT was in good working condition during the tests, with no known defects.

##### 3.1.1 FCC Section 15.203 & RSS-GEN Antenna Requirements

The antenna is permanently attached to the printed circuit board. Therefore, it meets the 15.203 Requirements.

### 4.0 TESTED SYSTEM DETAILS

#### 4.1 Tested System Configuration

The system was configured for testing in a typical fashion. The EUT was placed on an 80-cm or 150 cm high, nonconductive test stand. The testing was performed in conditions as close as possible to installed conditions. Wiring was consistent with manufacturer's recommendations.

Since the EUT is wall mounted or table mounted, it was placed in an upright and table-mounted configuration during the tests. Power was supplied with a new battery.

The identification for all equipment, plus descriptions of all cables used in the tested system, are:

**Tested System Configuration List**

Item	Description	Type*	Manufacturer	Model Number	Serial Number
1	BLE converter	E	Firefly Integrations, LLC	MIRABLERVC	none

\* Type: E = EUT, P = Peripheral, S = Support Equipment; H = Host Computer

**List of System Cables**

QTY	Length (m)	Cable Description	Shielded?
1	1.0	DC Cord to battery	No
1	1.8	Ethernet cable to router or termination	No

#### 4.2 Special Accessories

No special accessories were used during the tests in order to achieve compliance.

#### 4.3 Equipment Modifications

No modifications were made to the EUT at Radiometrics' test facility in order to comply with the standards listed in this report.

## 5.0 TEST SPECIFICATIONS

Document	Date	Title
FCC CFR Title 47	2017	Code of Federal Regulations Title 47, Chapter 1, Federal Communications Commission, Part 15 - Radio Frequency Devices
IC RSS-210 Issue 9	2016	Low Power Licence-Exempt Radiocommunication Devices (All Frequency Bands) Category I Equipment
IC RSS-Gen Issue 4	2014	General Requirements and Information for the Certification of Radiocommunication Equipment (RSS-Gen)

## 6.0 TEST PROCEDURE DOCUMENTS

The tests were performed using the procedures from the following specifications:

Document	Date	Title
ANSI C63.4-2014	2014	Methods of Measurement of Radio Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
ANSI C63.10-2013	2013	American National Standard for Testing Unlicensed Wireless Devices

## 7.0 RADIOMETRICS' TEST FACILITIES

The results of these tests were obtained at Radiometrics Midwest Corp. in Romeoville, Illinois, USA. Radiometrics is accredited by A2LA (American Association for Laboratory Accreditation) to conform to ISO/IEC 17025: 2005 "General Requirements for the Competence of Calibration and Testing Laboratories". Radiometrics' Lab Code is 121191 and Certification Number is 1495.01. Radiometrics' scope of accreditation includes all of the test methods listed herein. A copy of the accreditation can be accessed on our web site ([www.radiomet.com](http://www.radiomet.com)). Radiometrics accreditation status can be verified at A2LA's web site ([www.a2la2.org](http://www.a2la2.org)).

The following is a list of shielded enclosures located in Romeoville, Illinois used during the tests:

Chamber E: Is a custom made anechoic chamber that measures 52' L X 30' W X 18' H. The walls and ceiling are fully lined with RF absorber. Pro-shield of Collinsville, Oklahoma manufactured the chamber. The floor has a 9' x 9' section of microwave absorber for testing above 1 GHz.

Test Station F: Is an area that measures 10' D X 12' W X 10' H. The floor and back wall are metal shielded. This area is used for conducted emissions measurements.

A separate ten-foot long, brass plated, steel ground rod attached via a 6-inch copper braid grounds each of the above chambers. Each enclosure is also equipped with low-pass power line filters.

The FCC has accepted these sites as test site number US1065. The FCC test site Registration Number is 732175. Details of the site characteristics are on file with the Industry Canada as site number IC 3124A-1.

A complete list of the test equipment is provided herein. The calibration due dates are indicated on the equipment list. The equipment is calibrated in accordance to ANSI/NCSL Z540-1 with traceability to the National Institute of Standards and Technology (NIST).

## 8.0 DEVIATIONS AND EXCLUSIONS FROM THE TEST SPECIFICATIONS

There were no deviations or exclusions from the test specifications.

## 9.0 CERTIFICATION

Radiometrics Midwest Corporation certifies that the data contained herein was taken under conditions that meet or exceed the requirements of the test specification and the data contained herein was taken with calibrated test equipment. The results relate only to the EUT listed herein.

## 10.0 TEST EQUIPMENT TABLE

RMC ID	Manufacturer	Description	Model No.	Serial No.	Frequency Range	Cal Period	Cal Date
AMP-05	RMC/Celeritek	Pre-amplifier	MW110G	1001	1.0-12GHz	12 Mo.	01/09/17
AMP-20	Avantek	Pre-amplifier	SF8-0652	15221	8-18GHz	12 Mo	04/11/17
AMP-22	Anritsu	Pre-amplifier	MH648A	M23969	0.1-1200MHz	12 Mo.	01/09/17
AMP-59	Amplitech	Pre-amplifier	APTMP44	AMP-59	18-26 GHz	12 Mo.	01/04/17
ANT-03	Tensor	Biconical Antenna	4104	2231	20-250MHz	24 Mo.	12/07/15
ANT-04	Tensor	Biconical Antenna	4104	2246	20-250MHz	24 Mo.	05/16/16
ANT-06	EMCO	Log-Periodic Ant.	3146	1248	200-1000MHz	24 Mo.	11/25/15
ANT-13	EMCO	Horn Antenna	3115	2502	1.0-18GHz	24 Mo.	12/28/16
ANT-44	Imp Machine	Super Log Antenna	SL-20M2G	1002	20-2000MHz	24 Mo.	01/19/16
ANT-48	RMC	Std Gain Horn	HW2020	1001	18-26 GHz	24 Mo.	12/15/15
CAB-106A	Teledyne	Coaxial Cable	N/A	1090	DC-2 GHz	24 Mo.	04/21/16
CAB-1090	Teledyne	Coaxial Cable	N/A	1090	DC-18 GHz	24 Mo.	04/19/16
CAB-160B	Teledyne	Coaxial Cable	N/A	1090	DC-18 GHz	24 Mo.	04/21/16
HPF-06	Mini-Circuits	High Pass Filter	VHF-3800+	31035	3-11 GHz	24 Mo.	03/31/16
REC-20	HP / Agilent	Spectrum Analyzer	85460A/84562A	33330A00135 3410A00178	30Hz-6GHz	24 Mo.	07/13/16
REC-21	Agilent	Spectrum Analyzer	E7405A	MY45118341	9Hz-26.5 GHz	24 Mo.	12/22/15
THM-03	Fluke	Temp/Humid Meter	971	95850465	N/A	12 Mo.	02/20/17

Note: All calibrated equipment is subject to periodic checks.

Software Company	Test Software Name	Version	Applicable Tests
Radiometrics	REREC11D	01.05.16	RF Radiated Emissions (FCC Part 15 & EN 55011/22)
Agilent	PSA/ESA-E/L/EMC	2.4.0.42	Bandwidth and screen shots

## 11.0 TEST SECTIONS

### 11.1 Radiated RF Emissions

Radiated emission measurements were performed with linearly polarized broadband antennas. The results obtained with these antennas can be correlated with results obtained with a tuned dipole antenna. The radiated emission measurements were performed with a spectrum analyzer. The bandwidth used from 150 kHz to 30 MHz is 9 or 10 kHz and the bandwidth from 30 MHz to 1000 MHz is 100 or 120 kHz. Above 1 GHz, a 1 MHz bandwidth is used. A 10 dB linearity check is performed prior to start of testing in order to determine if an overload condition exists. A harmonic mixer was used from 18 to 25 GHz. Figure 4 herein lists the details of the test equipment used during radiated emissions tests.

Testing of the Firefly Integrations, LLC, Model MIRABLERVC, CAN bus to BLE and Ethernet Bridge

In addition, a high pass filter was used to reduce the fundamental emission. High pass filters were not needed above 10 GHz, since the preamplifiers attenuated the fundamental emission.

The EUT was rotated through three orthogonal axis as per 5.10.1 of ANSI C63.10 during the radiated tests.

Final radiated emissions measurements were performed inside of an anechoic chamber at a test distance of 3 meters. The anechoic chamber is designated as Chamber E. This Chamber meets the Site Attenuation requirements of ANSI C63.4 and CISPR 16-1. Chamber E is located at 12 East Devonwood Ave. Romeoville, Illinois EMI test lab.

The entire frequency range from 30 to 25,000 MHz was slowly scanned with particular attention paid to those frequency ranges which appeared high. Measurements were performed using two antenna polarizations, (vertical and horizontal). The worst case emissions were recorded. All measurements may be performed using either the peak, average or quasi-peak detector functions. If the peak detector data exceeds or is marginally close to the limits, the measurements are repeated using a quasi-peak detector or average function as required by the specification for final determination of compliance.

The detected emission levels were maximized by rotating the EUT, adjusting the positions of all cables, and by scanning the measurement antenna from 1 to 4 meters above the ground.

### 11.1.1 Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Loss, and by subtracting the Amplifier Gain from the measured reading. The basic equation is as follows:

$$FS = RA + AF + CF - AG + HPF + PKA$$

Where: FS = Field Strength

RA = Receiver Amplitude

AF = Antenna Factor

CF = Cable Attenuation Factor

AG = Amplifier Gain

HPF = High pass Filter Loss

PKA = Peak to Average Factor (This is only used for average measurements above 1 GHz)

The Peak to average factor is used when average measurements are required. It is calculated by the highest duty cycle in percent over any 100mS transmission.

Note: The actual FCC limits are in uV/m. The data in the results table converted the limits to dBuV/m.

100 uV/m = 40.0 dBuV/m

150 uV/m = 43.5 dBuV/m

200 uV/m = 46.0 dBuV/m

500 uV/m = 54.0 dBuV/m

### 11.1.2 Duty Cycle

The Peak to average factor is calculated by the highest duty cycle in percent over any 100mS transmission. The transmitter operates for a maximum duration of 21.56 ms in any 100 ms interval for a 10% maximum duty cycle.  $20 \log^*(21.56 \text{ mSec}/100\text{mSec}) = -13.3 \text{ dB}$  Peak to Average correction factor.

The transmitter sends the data in 280 microsecond pulses. At most, there are 77 of these transmissions in any 100 mSec, for a maximum transmitter duty cycle of 21.56%.

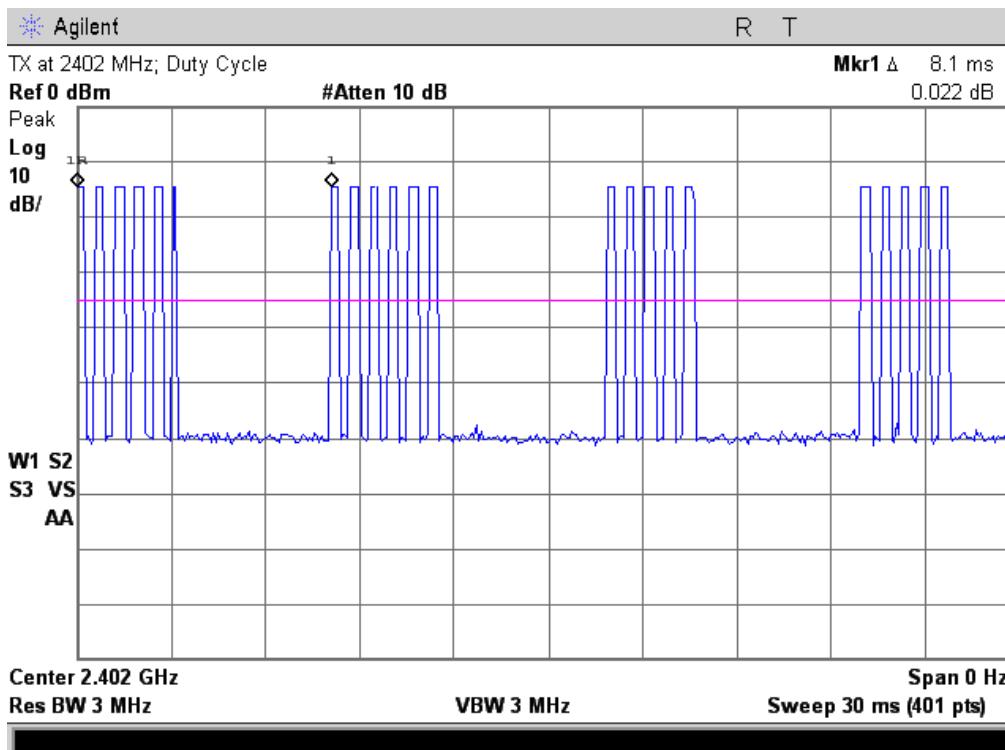
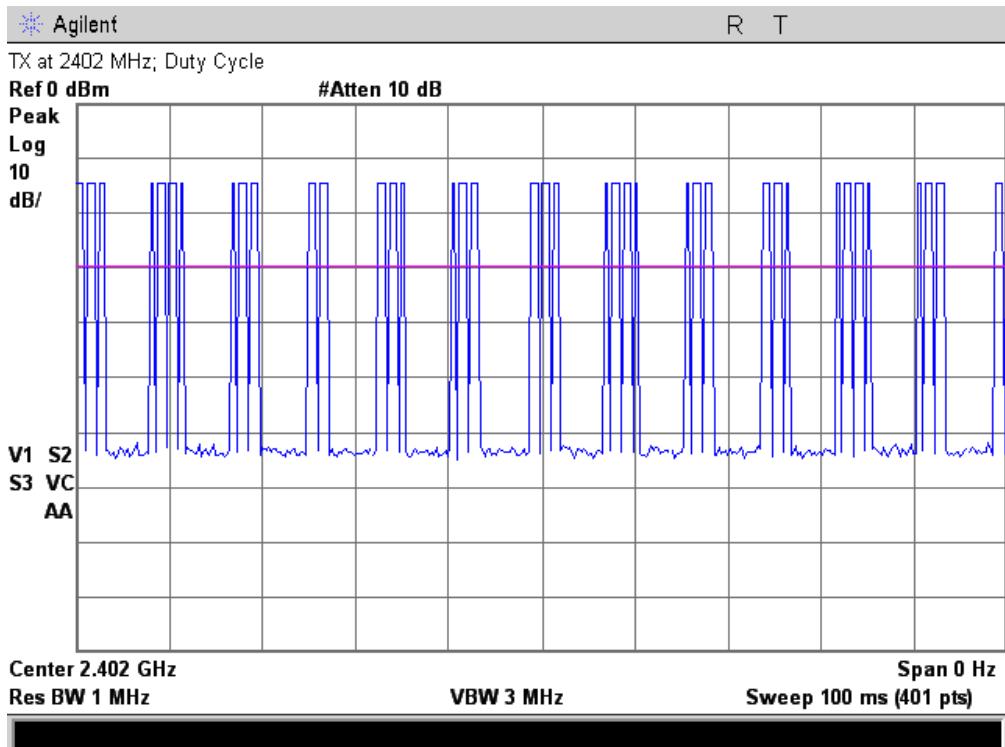
In accordance to 7.5 of ANSI C63.10 the following procedures were used.

- a) The EUT was set to the “worst-case” pulse ON time.
- b) The RF output was Coupled to the input of a spectrum analyzer by a “near-field” coupling method. The signal received shall be of sufficient level to trigger adequately the spectrum analyzer sweep display.
- c) The center frequency of the spectrum analyzer was set to the center of the RF signal.
- d) The spectrum analyzer was set for ZERO SPAN.
- e) The sweep time was of the analyzer was set to 100 ms and other times to show the duty cycle.
- f) Since the pulse train has a period that exceeds 100 ms, or as an alternative to step f), then:
  - 1) The trigger on the spectrum analyzer was set to capture the greatest amount of pulse “ON time” over 100 ms.
  - 2) The 100 ms period that contains the maximum “on time” was found.
  - 3) The duty cycle was determined by dividing the total maximum “ON time” by 100 ms ( $t_{ON}/100\text{ ms}$ ).
- h) The duty cycle correction factor was used applying Equation (10) of ANSI C63.10 to the duty cycle determined in the preceding steps.



The width of each pulse is 280uSec.

## Testing of the Firefly Integrations, LLC, Model MIRABLERVC, CAN bus to BLE and Ethernet Bridge



There are, at most, 6 pulses in every pulse train. The pulse trains are separated by 8.1 mSec. There are 12 full pulse trains, with 5 additional pulses for a total of 77 pulses.

Testing of the Firefly Integrations, LLC, Model MIRABLERVC, CAN bus to BLE and Ethernet Bridge

### 11.1.3 Radiated Emissions Test Results

Test Date	9/26 & 10/9/2017
Test Distance	3 Meters
Specification	FCC Part 15 Subpart C & RSS-210 Section B.10
Abbreviations	Pol = Antenna Polarization; V = Vertical; H = Horizontal; P = peak; Q = QP

All emissions except Fundamental and harmonics; Emissions in Transmit Mode

Freq. MHz	Meter Reading dBuV	Dect.	Ant. Pol.	Ant Factor	Cable & Amp Factors	Dist. Fact dB	EUT dBuV/m	Limit dBuV/m	Margin Under Limit dB	Note
46.8	10.0	P	H	11.8	0.6	0.0	22.4	40.0	17.6	
73.0	11.5	P	H	6.4	0.7	0.0	18.6	40.0	21.4	
133.6	12.6	P	H	11.7	1.0	0.0	25.2	40.0	14.8	
179.6	18.4	Q	H	16.9	1.1	0.0	36.4	40.0	3.6	
236.2	17.2	P	H	10.3	1.3	0.0	28.8	47.0	18.2	
351.8	11.2	P	H	14.1	1.6	0.0	26.8	47.0	20.2	
488.4	12.5	P	H	17.4	1.9	0.0	31.8	47.0	15.2	
562.5	11.3	P	H	18.6	2.0	0.0	31.9	47.0	15.1	
751.3	9.9	P	H	20.2	2.4	0.0	32.5	47.0	14.5	
970.0	9.6	P	H	22.5	2.7	0.0	34.8	47.0	12.2	
1110.0	43.0	P	H	24.4	-32.7	0.0	34.7	74.0	39.3	1
1505.0	41.3	P	H	25.1	-32.5	0.0	33.9	74.0	40.1	1
1922.5	45.8	P	H	27.2	-31.8	0.0	41.2	74.0	32.8	1
2217.5	40.3	P	H	27.7	-31.8	0.0	36.1	74.0	37.9	1
2607.5	44.8	P	H	28.7	-30.9	0.0	42.6	74.0	31.4	1
2920.0	43.3	P	H	29.6	-30.6	0.0	42.3	74.0	31.7	1
3232.5	40.2	P	H	31.0	-29.9	0.0	41.3	74.0	32.7	1
3512.5	41.1	P	H	31.3	-29.4	0.0	43.0	74.0	31.0	1
3900.0	39.7	P	H	32.8	-29.2	0.0	43.2	74.0	30.8	1
42.0	14.4	P	V	12.0	0.5	0.0	26.9	40.0	13.1	
76.4	14.5	P	V	6.4	0.7	0.0	21.6	40.0	18.4	
92.8	13.9	P	V	10.4	0.8	0.0	25.1	40.0	14.9	
120.3	15.5	P	V	12.4	0.9	0.0	28.8	40.0	11.2	
134.9	15.3	P	V	11.6	1.0	0.0	27.9	40.0	12.1	
147.4	16.7	P	V	12.7	1.0	0.0	30.4	40.0	9.6	
178.4	8.4	Q	V	16.8	1.1	0.0	26.3	40.0	13.7	
244.5	11.5	P	V	10.8	1.3	0.0	23.6	47.0	23.4	
349.5	11.4	P	V	14.0	1.6	0.0	27.0	47.0	20.0	
478.6	13.1	P	V	17.7	1.9	0.0	32.6	47.0	14.4	
568.8	9.7	P	V	18.3	2.1	0.0	30.1	47.0	16.9	
806.3	11.7	P	V	20.6	2.6	0.0	34.9	47.0	12.1	
926.3	9.0	P	V	22.6	2.7	0.0	34.3	47.0	12.7	
1500.0	41.1	P	V	25.1	-32.5	0.0	33.7	74.0	40.3	1
1922.5	49.4	P	V	27.2	-31.8	0.0	44.8	74.0	29.2	1
2215.0	41.1	P	V	27.7	-31.8	0.0	37.0	74.0	37.0	1
2517.5	40.5	P	V	28.5	-30.9	0.0	38.0	74.0	36.0	1
2897.5	43.3	P	V	29.4	-30.7	0.0	42.0	74.0	32.0	1
3155.0	41.6	P	V	30.8	-29.8	0.0	42.5	74.0	31.5	1
3492.5	39.1	P	V	31.3	-29.5	0.0	40.9	74.0	33.1	1
3912.5	40.9	P	V	32.8	-29.3	0.0	44.5	74.0	29.5	1

Note 1: Peak Reading under the Average limit, therefore no Average reading is required.

Judgment: Passed by at least 3.6 dB

Testing of the Firefly Integrations, LLC, Model MIRABLERVC, CAN bus to BLE and Ethernet Bridge

Fundamental and Harmonic Emissions FCC 15.249; Three axis tested

		Spectrum Analyzer Readings								EUT	Peak	Ave	Peak	Ave	Margin	
hrm	Tx	Peak		Ave	Peak		Ave	Corr.	Emission	Tot. FS		Limit		Under		
#	Freq	Vertical Polarization				Horizontal Polarization				Fact.	Freq MHz	dBuV/m		dBuV/m		Limit
		X	Y	Z	Max	X	Y	Z	Max							
1	2402	92.8	105.3	102.6	92.0	99.8	95.8	98.7	86.5	-2.8	2402.0	102.5	89.2	114	94	4.8
BE	2402	48.3	60.8	58.1	47.4	55.3	51.3	54.2	41.9	-2.8	2400.0	58.0	44.6	74	54	9.4
2	2402	42.0	46.7	42.6	33.4	45.3	42.5	43.6	32.0	7.8	4804.0	54.5	41.2	74	54	12.8
3	2402	40.1	40.5	39.6	27.2	39.7	39.6	39.6	26.4	12.0	7206.0	52.5	39.2	74	54	14.8
1	2440	91.3	106.4	103.1	93.1	103.1	97.4	101.0	89.8	-2.6	2440.0	103.8	90.5	114	94	3.5
2	2440	41.1	42.4	41.1	29.1	41.3	41.4	41.6	28.3	8.1	4880.0	50.5	37.2	74	54	16.8
3	2440	41.6	41.0	41.7	28.4	41.7	41.1	41.1	28.4	12.6	7320.0	54.3	41.0	74	54	13.0
4	2440	40.0	40.6	40.7	27.4	40.2	41.0	40.5	27.7	18.9	9760.0	59.9	46.6	74	54	7.4
1	2480	94.3	104.1	102.2	90.8	99.9	95.4	99.9	86.6	-2.6	2480.0	101.5	88.2	114	94	5.8
BE	2480	48.3	58.1	56.2	44.8	53.9	49.4	53.9	40.6	-2.6	2483.5	55.5	42.2	74	54	11.8
2	2480	42.8	39.8	41.9	29.5	39.4	43.2	41.9	29.9	7.9	4960.0	51.1	37.8	74	54	16.2
3	2480	42.1	41.8	38.9	28.8	37.9	41.6	38.7	28.3	13.0	7440.0	55.1	41.8	74	54	12.2
4	2480	35.0	32.9	33.6	21.7	34.4	33.7	35.9	22.6	17.0	9920.0	52.9	39.6	74	54	14.4
Column numbers (see below for explanations)																
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17

Column #1. hrm = Harmonic; BE = Band Edge emissions

Column #2. Frequency of Transmitter.

Column #3. Uncorrected readings from the spectrum analyzer with First Axis Rotation.

Column #4. Uncorrected readings from the spectrum analyzer with Second Axis Rotation.

Column #5. Uncorrected readings from the spectrum analyzer with Third Axis Rotation.

Column #6. Average Reading based on peak reading reduced by the Duty cycle correction

Column #7. Uncorrected readings from the spectrum analyzer with First Axis Rotation.

Column #8. Uncorrected readings from the spectrum analyzer with Second Axis Rotation.

Column #9. Uncorrected readings from the spectrum analyzer with Third Axis Rotation.

Column #10. Average Reading based on peak reading reduced by the Duty cycle correction

Column #11. Corr. Factors = Cable Loss – Preamp Gain + Antenna Factor

Column #12. Frequency of Tested Emission

Column #13. Highest peak field strength at listed frequency.

Column #14. Highest Average field strength at listed frequency.

Column #15. Peak Limit. (Fundamental limit is 15.249, Harmonics are 15.209)

Column #16. Average Limit. (Fundamental limit is 15.249, Harmonics are 15.209)

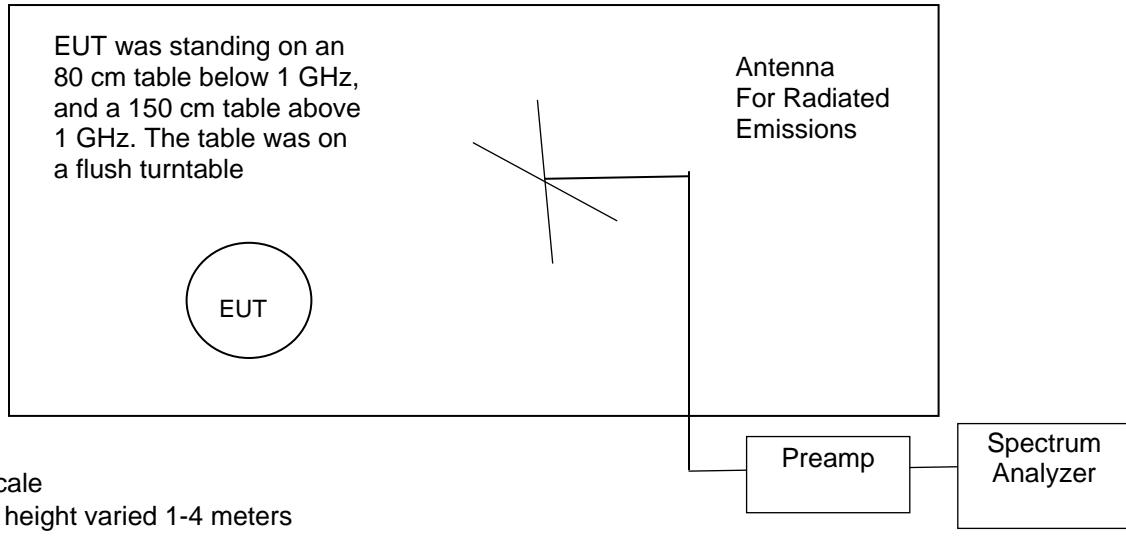
Column #17. The margin (last column) is the worst case margin under the peak or average limits for that row.

Overall Judgment: Passed by at least 3.5 dB

No other Emissions were detected from 30 to 25,000 MHz within 10 dB of the limits.

**Figure 1. Drawing of Radiated Emissions Setup**

Chamber E, anechoic



Frequency Range	Receive Antenna	Pre-Amplifier	Spectrum Analyzer	High Pass Filter
30 to 200 MHz	ANT-04	AMP-22	REC-21	None*
200 to 1000 MHz	ANT-06	AMP-22	REC-21	None*
1 to 10 GHz	ANT-13	AMP-05	REC-21	HPF-03

\* A high pass filter was not needed since the fundamental frequency was outside of the amplifiers pass band.

**11.2 Occupied Bandwidth Data**

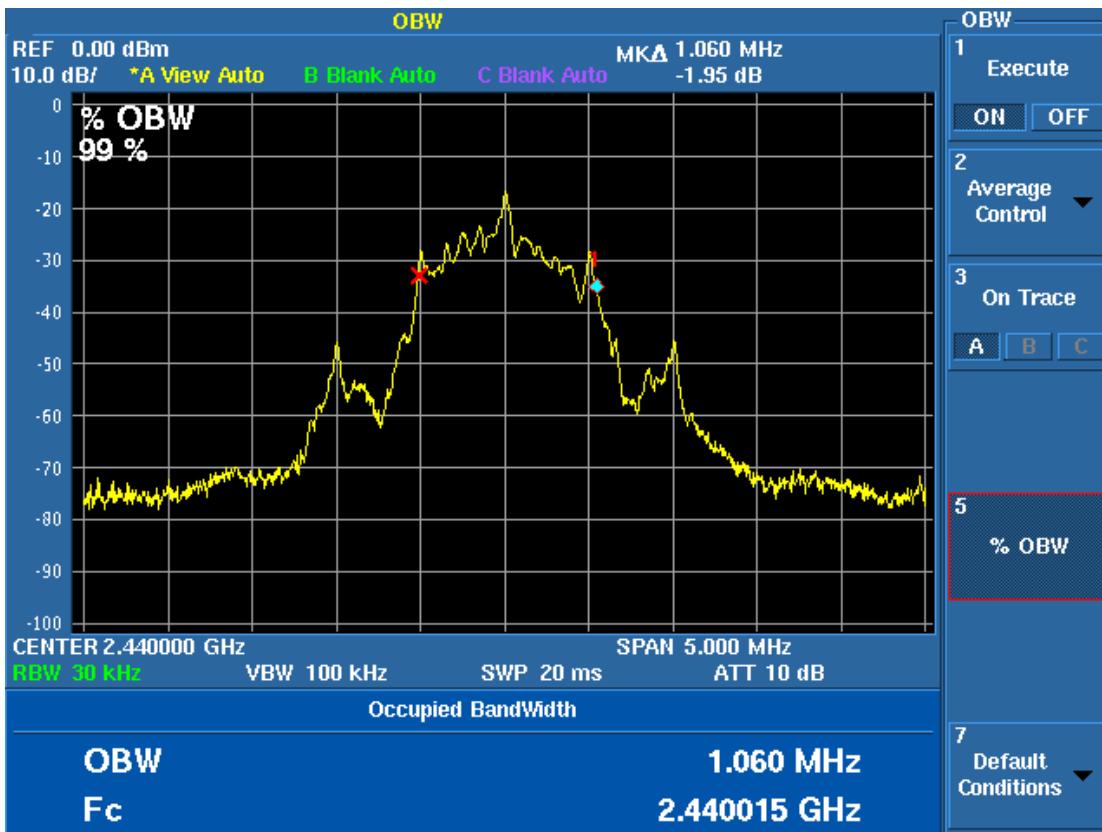
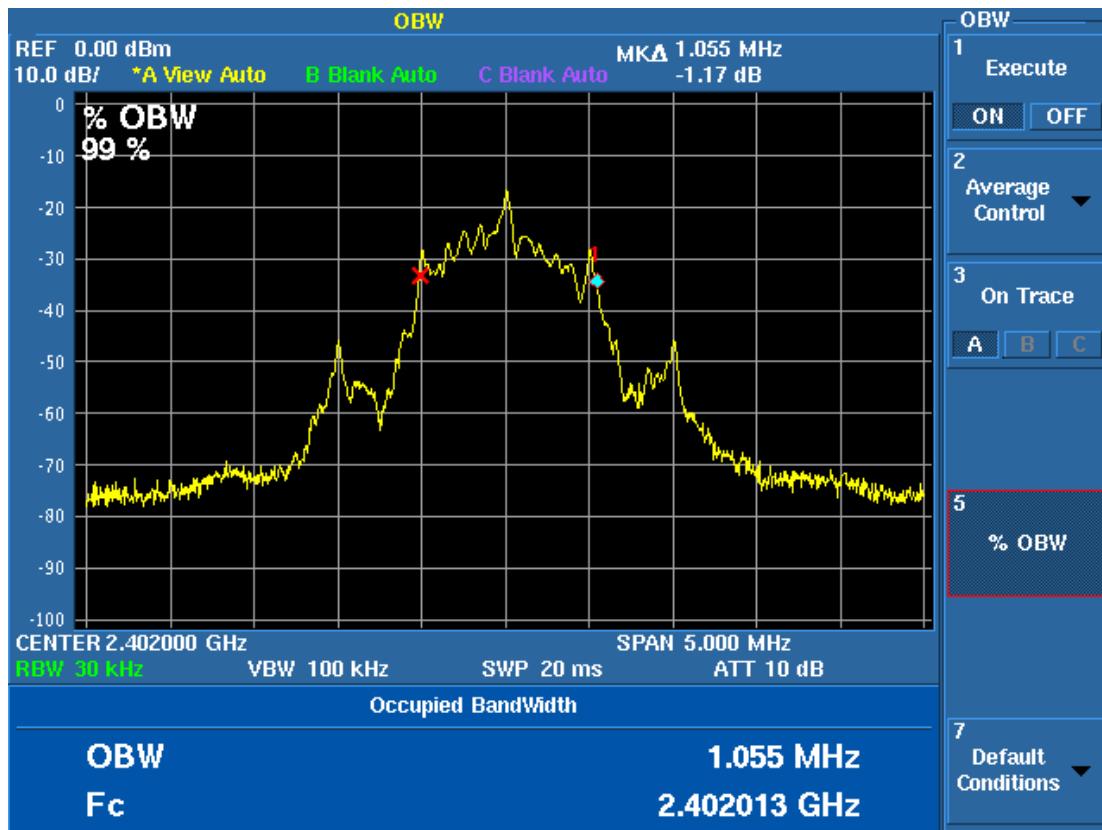
The occupied bandwidth of the RF output was measured using a spectrum analyzer. The bandwidth was measured using the peak detector function and a narrow resolution bandwidth.

A broadband antenna was used to receive the modulated signal. The spectrum analyzer was set to the MAX HOLD mode to record the worst case of the modulation. The spectrum analyzer display was digitized and plotted. A limit was drawn on the plots based on the level of the modulated carrier. The plots of the occupied bandwidth for the EUT are supplied on the following page.

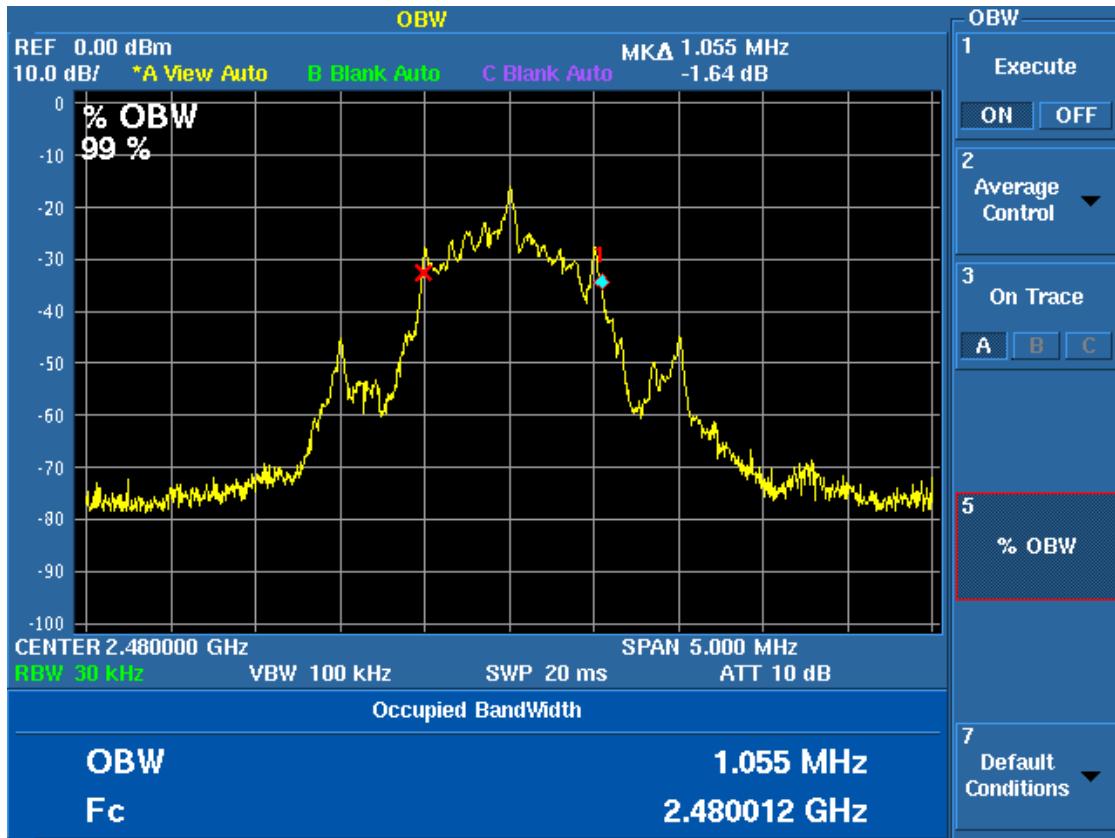
Channel MHz	99% EBW MHz
2402	1.055
2440	1.060
2480	1.055

Judgement: Pass

Figure 2. Occupied Bandwidth Plot



Testing of the Firefly Integrations, LLC, Model MIRABLERVC, CAN bus to BLE and Ethernet Bridge



### 11.3 Unintentional Emissions (Receive Mode)

Manufacturer	Firefly Integrations, LLC	Specification	FCC Part 15.209 & RSS-GEN
Model	MIRABLERVC	Test Date	October 9, 2017
Serial Number	none	Test Distance	3 Meters
Abbreviations	Pol = Antenna Polarization; V = Vertical; H = Horizontal; P = peak; Q = QP		
Notes	Corr. Factors = Cable Loss – Preamp Gain		
Configuration	Receive mode		

Freq. MHz	Meter Reading dBuV	Dect.	Ant. Pol.	Ant Factor	Cbl/amp Factors	Dist Fact dB	EUT dBuV/m	Limit dBuV/m	Margin Under Limit dB	Note
30.0	31.0	P	H	11.1	-28.3	0.0	13.8	40.0	26.2	
33.0	45.6	P	H	11.3	-28.2	0.0	28.7	40.0	11.3	
67.0	32.3	P	H	7.4	-28.0	0.0	11.6	40.0	28.4	
140.9	36.1	P	H	11.8	-27.6	0.0	20.3	43.5	23.2	
153.8	48.5	P	H	13.9	-27.5	0.0	34.9	43.5	8.6	
161.6	47.5	P	H	15.2	-27.4	0.0	35.3	43.5	8.2	
176.2	44.2	P	H	16.7	-27.4	0.0	33.5	43.5	10.0	
200.0	41.4	P	H	11.0	-27.3	0.0	25.1	43.5	18.4	
205.3	43.2	P	H	10.6	-27.2	0.0	26.6	43.5	16.9	
246.1	36.1	P	H	10.9	-27.2	0.0	19.8	46.0	26.2	
300.4	33.3	P	H	14.4	-27.0	0.0	20.7	46.0	25.3	
329.9	36.6	P	H	13.7	-27.3	0.0	23.0	46.0	23.0	
415.9	32.6	P	H	15.3	-27.0	0.0	20.9	46.0	25.1	
434.8	32.9	P	H	15.6	-27.0	0.0	21.4	46.0	24.6	

## Testing of the Firefly Integrations, LLC, Model MIRABLERVC, CAN bus to BLE and Ethernet Bridge

Freq. MHz	Meter Reading dBuV	Dect.	Ant. Pol.	Ant Factor	Cbl/amp Factors	Dist Fact dB	EUT dBuV/m	Limit dBuV/m	Margin Under Limit dB	Note
502.0	30.7	P	H	17.8	-26.1	0.0	22.4	46.0	23.6	
653.8	32.9	P	H	20.3	-26.0	0.0	27.2	46.0	18.8	
722.5	32.9	P	H	21.0	-26.0	0.0	27.9	46.0	18.1	
838.8	32.5	P	H	21.9	-25.2	0.0	29.3	46.0	16.7	
1960.0	41.2	P	H	27.2	-31.7	0.0	36.7	74.0	37.3	1
2497.5	39.3	P	H	28.4	-30.9	0.0	36.8	74.0	37.2	1
2895.0	40.9	P	H	29.4	-30.6	0.0	39.6	74.0	34.4	1
2997.5	40.2	P	H	30.1	-30.0	0.0	40.3	74.0	33.7	1
3567.5	38.4	P	H	31.4	-29.1	0.0	40.8	74.0	33.2	1
3900.0	39.6	P	H	32.8	-29.1	0.0	43.3	74.0	30.7	1
4027.5	37.4	P	H	32.7	-28.8	0.0	41.2	74.0	32.8	1
4732.5	37.2	P	H	33.3	-27.2	0.0	43.3	74.0	30.7	1
4975.0	36.2	P	H	33.3	-26.5	0.0	42.9	74.0	31.1	1
6022.5	36.4	P	H	34.4	-24.8	0.0	46.0	74.0	28.0	1
30.0	30.6	P	V	11.1	-28.3	0.0	13.4	40.0	26.6	
34.7	39.0	P	V	11.5	-28.2	0.0	22.3	40.0	17.7	
35.6	34.0	P	V	11.6	-28.2	0.0	17.4	40.0	22.6	
45.5	33.4	P	V	11.9	-28.1	0.0	17.2	40.0	22.8	
48.9	33.7	P	V	11.5	-28.1	0.0	17.1	40.0	22.9	
61.4	33.5	P	V	8.7	-28.1	0.0	14.1	40.0	25.9	
73.9	36.9	P	V	6.3	-27.9	0.0	15.3	40.0	24.7	
116.0	35.6	P	V	12.5	-27.7	0.0	20.4	43.5	23.1	
117.7	39.9	P	V	12.4	-27.7	0.0	24.6	43.5	18.9	
146.1	48.7	P	V	12.5	-27.5	0.0	33.7	43.5	9.8	
158.1	48.2	P	V	14.7	-27.4	0.0	35.5	43.5	8.0	
173.2	42.7	P	V	16.4	-27.4	0.0	31.7	43.5	11.8	
193.8	41.9	P	V	16.8	-27.4	0.0	31.3	43.5	12.2	
203.0	42.2	P	V	10.8	-27.3	0.0	25.7	43.5	17.8	
252.1	37.4	P	V	11.3	-27.1	0.0	21.6	46.0	24.4	
266.4	36.3	P	V	12.3	-27.1	0.0	21.6	46.0	24.4	
329.9	34.5	P	V	13.7	-27.3	0.0	20.8	46.0	25.2	
427.3	36.4	P	V	15.9	-27.2	0.0	25.1	46.0	20.9	
517.5	32.4	P	V	17.7	-26.6	0.0	23.5	46.0	22.5	
537.5	32.0	P	V	17.1	-26.4	0.0	22.7	46.0	23.3	
787.5	31.8	P	V	20.7	-25.4	0.0	27.0	46.0	19.0	
912.5	31.1	P	V	22.5	-24.6	0.0	29.0	46.0	17.0	
1000.0	40.0	P	V	24.1	-32.7	0.0	31.4	54.0	22.6	
1745.0	43.6	P	V	26.2	-32.2	0.0	37.6	74.0	36.4	1
2450.0	41.5	P	V	28.4	-30.9	0.0	39.0	74.0	35.0	1
2750.0	41.6	P	V	28.9	-30.9	0.0	39.5	74.0	34.5	1
2962.5	43.7	P	V	29.9	-30.2	0.0	43.3	74.0	30.7	1
3135.0	42.2	P	V	30.8	-29.8	0.0	43.3	74.0	30.7	1
3647.5	41.3	P	V	31.7	-28.8	0.0	44.2	74.0	29.8	1
4127.5	38.0	P	V	32.5	-28.2	0.0	42.3	74.0	31.7	1
4445.0	37.6	P	V	32.8	-27.9	0.0	42.5	74.0	31.5	1
5050.0	37.9	P	V	33.5	-26.7	0.0	44.7	74.0	29.3	1
5475.0	37.1	P	V	34.1	-25.4	0.0	45.7	74.0	28.3	1
5922.5	37.6	P	V	34.1	-25.5	0.0	46.3	74.0	27.7	1

Note 1: Peak Reading under the Average limit, therefore no Average reading is required.

Judgment: Passed by at least 8.0 dB

### 11.3.1 Measurement Instrumentation Uncertainty

Measurement	Uncertainty
Radiated Emissions, E-field, 3 meters, 30 to 200 MHz	3.3 dB
Radiated Emissions, E-field, 3 meters, 200 to 1000 MHz	4.9 dB
Radiated Emissions, E-field, 3 meters, 1 to 8 GHz	4.8 dB
99% Occupied Bandwidth using REC-43	1% of frequency span
Temperature THM-02	0.6 Deg C

The uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k=2 in accordance with CISPR 16-4-2.