

# Test Report # 317399 C

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**Equipment Under Test:** USB Wireless Adapter

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**Test Date(s):** 7/11/18

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ATTN: Michael Caruthers

Caterpillar Inc.

**Prepared for:**  
100 North East Adams Street  
Peoria, IL 61629

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**Report Issued by:** Shane Dock, EMC Engineer

Signature:



Date: 4/9/2019

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**Report Reviewed by:** Adam Alger, Quality Manager

Signature: 

Date: 04/25/2018

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**Report Constructed by:** Shane Dock, EMC Engineer

Signature:



Date: 4/25/2018

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## Laird Technologies Test Services in Review

The Laird Technologies, 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: 2005 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 recognition of two 3 meter Semi-Anechoic Chambers*

*Accredited Test Firm Registration Number: 953492*



Government  
of Canada

### Innovation, Science and Economic Development Canada

*ISED Site listing of two 3 meter Semi-Anechoic Chambers based on RSS-GEN – Issue 4*

*File Number: IC 3088A-2*

*File Number: IC 3088A-3*

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## 1 TEST REPORT SUMMARY

On **3/6/18** the Equipment Under Test (EUT), **PQMWFIBT**, as provided by **Caterpillar Inc.** was tested to the following requirements:

Requirement	Description	Specification	Method	Result
FCC Part 1.1307, 2.1091, 2.1093	RF Exposure and equipment authorization requirements	Reported	FCC KDB 447498	Reported
ISED Canada RSS-102	Radiofrequency Radiation Exposure Evaluation: Portable	Reported	RSS-102 Section 2.5.2	Reported

### Notice:

The results relate only to the item tested and described in this report. Any modifications made to the equipment under test after the specified test date(s) may invalidate the data herein.

If the resulting measurement margin is seen to be within the uncertainty value, as listed in this report, the possibility exists that this unit may not meet the required limit specification if subsequently tested.

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## 2 CLIENT INFORMATION

Company Name	Caterpillar Inc.
Contact Person	Michael Caruthers
Address	Caterpillar Inc. 100 North East Adams Street Peoria, IL 61629

### 2.1 Equipment Under Test (EUT) Information

*The following information has been supplied by the client*

Product Name	USB Wireless Adapter
Model Number	WIFIBT
Serial Number	Conducted RF Unit: LK0X001712
FCC / IC ID	FCC ID: PQMWIFIBT IC ID: 4071A-WIFIBT

### 2.2 Product Description

The USB Wireless Adapter is a mobile device mounted on a vehicle/machine in order to provide Wi-Fi and Bluetooth Low Energy local connectivity. The Wi-Fi connectivity is to enable local basic diagnostic and service functionality allowing connection to the asset to monitor the health of the machine. The Bluetooth Low Energy connectivity is used for other sensing and detection. The Adapter connects to the existing Caterpillar network manager via a USB 2.0 interface. All processing capability resides on the network manager.

### 2.3 Modifications Incorporated for Compliance

Cable implemented to separate module from host board units.

### 2.4 Deviations and Exclusions from Test Specifications

None noted at time of test

### 2.5 Additional Information

EUT programmed via ethernet connection to host board, which is connected to the unit via USB cable. Unit is programmed with the Caterpillar\_USB\_Adapter\_Compliance\_App\_1749 program. Module is provided with 5V dc power from the host board. Per the manufacturer, the radios may not transmit at the same time.

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## 2.6 BLE Information

Unit tested at output power settings of 9 and -18, as the unit has a variable output power. The unit was tested at 2402 MHz, 2440 MHz, and 2480 MHz.

## 2.7 WLAN Information

Unit tested at output power settings of 14 (802.11b) and 10 (802.11g and 802.11n). The unit was tested at 2412 MHz, 2437 MHz, and 2462 MHz.

## 2.8 EUT Test Case

Per the manufacturer, the unit cannot be used with a laptop and can only be used with a Caterpillar display or a Caterpillar network manager. The EUT will always be at least 4.51 cm away from the operator. The radios cannot transmit at the same time.

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### 3 REFERENCES

Publication	Edition	Date
CFR 47 Part 15	-	2018
ANSI C63.10	-	2013
RSS-247	2	2017
RSS GEN	4	2014
RSS-102	5	2015
CFR 47 Part 1 and 2	-	2017
FCC KDB 447498	6	2015

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## 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	$1 \times 10^{-7}$	$0.55 \times 10^{-7}$
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 %

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## 5 TEST DATA

### 5.1 Fundamental Emission - BLE

<b>Operator</b>	Shane Dock
<b>Test Date</b>	1/10/18, 1/15/18
<b>Location</b>	Conducted RF Area
<b>Temp. / R.H.</b>	70 degrees F/34%
<b>Requirement</b>	FCC: 15.247 (b)(3) IC: RSS-247 5.4 (4)
<b>Method</b>	KDB 558074 Section 9.2.2.3

#### Limits: (Measured as Average)

Maximum Conducted Output Power (dBm)	Maximum Conducted Output Power (watts)
30	1

#### Test Parameters

<b>Frequency</b>	2402-2480 MHz
<b>Settings</b>	Low, Mid, and High Channels Measured
<b>Settings</b>	Unit measured at full power and minimum power

#### Table

##### Max Power (dBm)

Channel	Low	Mid	High
Output Power (dBm)	8.781	8.608	8.506

##### Min Power (dBm)

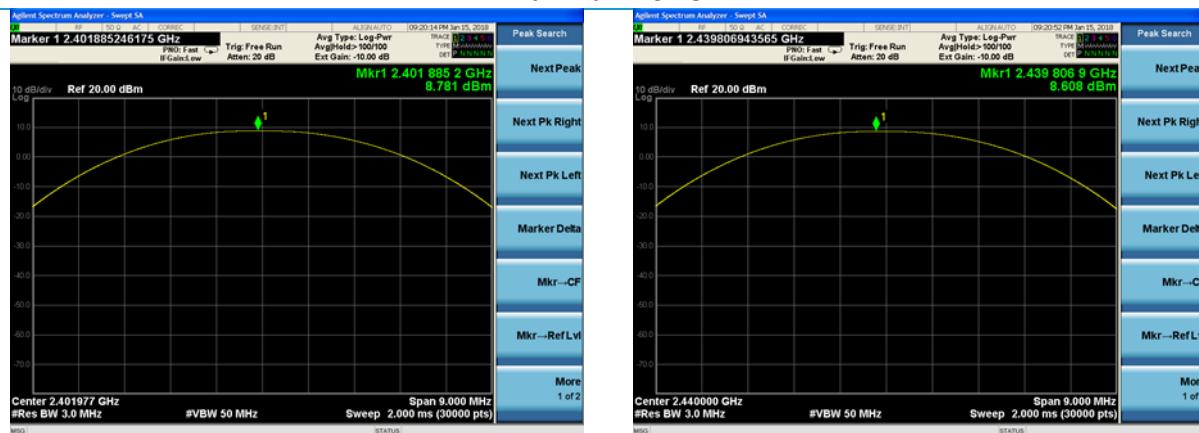
Channel	Low	Mid	High
Output Power (dBm)	-17.852	-17.910	-17.957

**Worst Case Margin = Limit - Closest Measurement = 30.0 dBm – 8.781 dBm = 21.219 dB**

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## Plots

### Maximum Power



Low Channel

Mid Channel

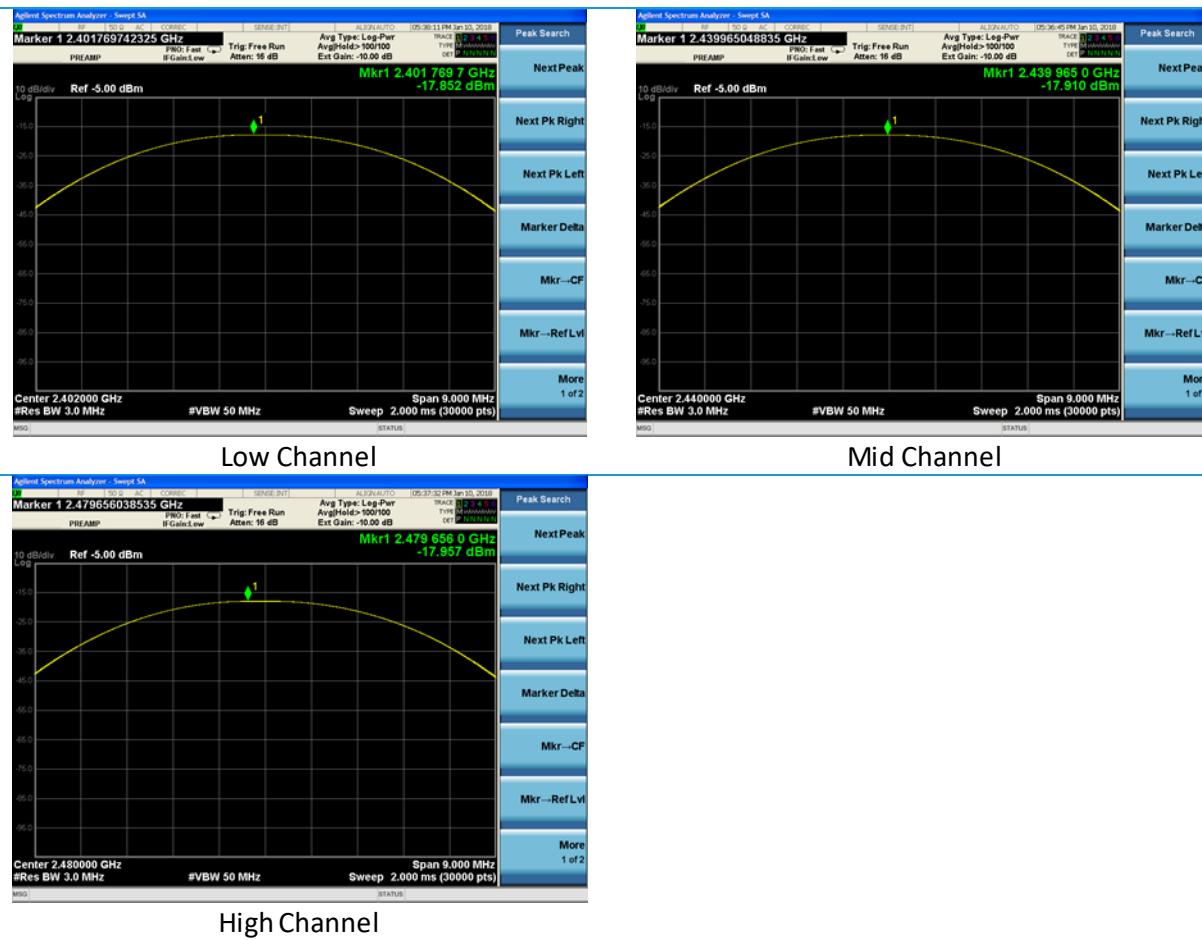


High Channel

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## Minimum Power



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## 5.2 Fundamental Emission – WLAN

<b>Operator</b>	Shane Dock
<b>Test Date</b>	12/27/17 – 4/6/18
<b>Location</b>	Conducted RF Area
<b>Temp. / R.H.</b>	70 degrees F / 23% RH
<b>Requirement</b>	FCC: 15.247 (b)(3) IC: RSS-247 5.4 (4)
<b>Method</b>	KDB 558074 Section 9.2.2.2

### Limits: (Measured as Average)

Maximum Conducted Output Power (dBm)	Maximum Conducted Output Power (watts)
30	1

### Test Parameters

<b>Frequency</b>	2412-2462 MHz
<b>Settings</b>	Low, Mid, and High Channels Measured

### Table

#### 1 MBPS

Channel	Low	Mid	High
Output Power (dBm)	13.861	14.082	14.051

#### 6 MBPS

Channel	Low	Mid	High
Output Power (dBm)	9.841	10.121	10.064

#### MCS0

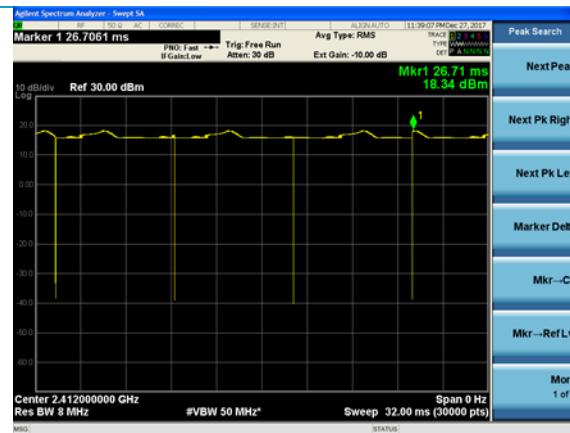
Channel	Low	Mid	High
Output Power (dBm)	10.026	10.282	10.233

**Worst Case Margin = Limit - Closest Measurement = 30.0 dBm – 14.082 dBm = 15.918 dB**

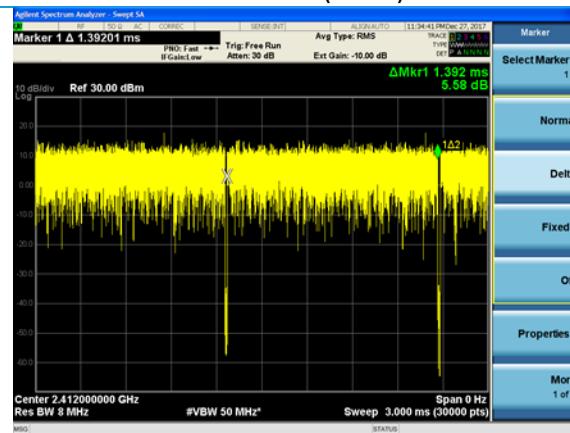
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## Plots

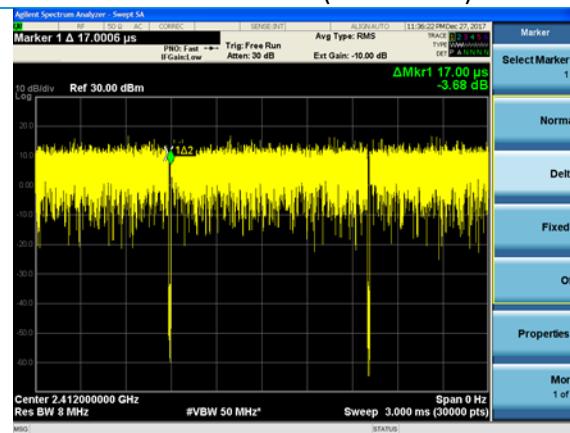
### Duty Cycle



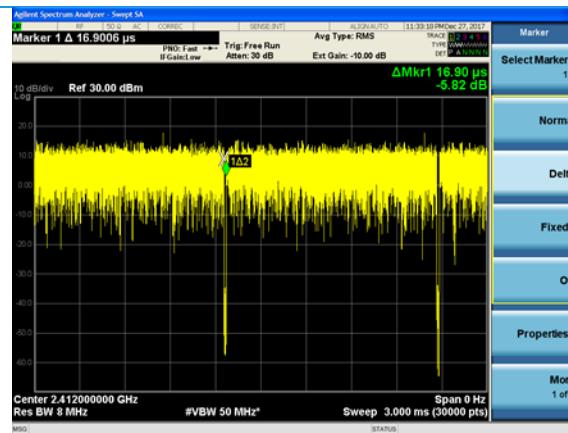
1 MBPS DC (>99%)



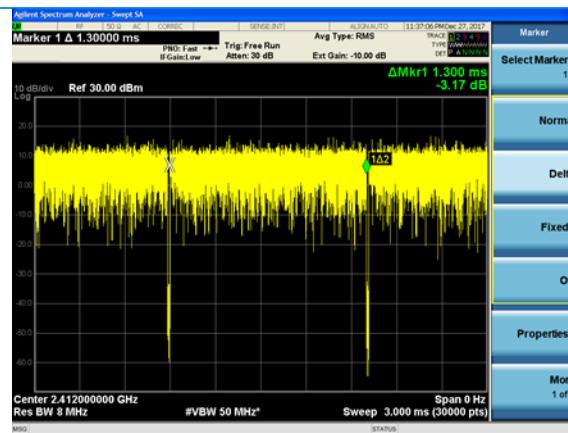
6 MBPS On Time (DC = 98.8%)



MCS0 On Time (DC = 98.7%)



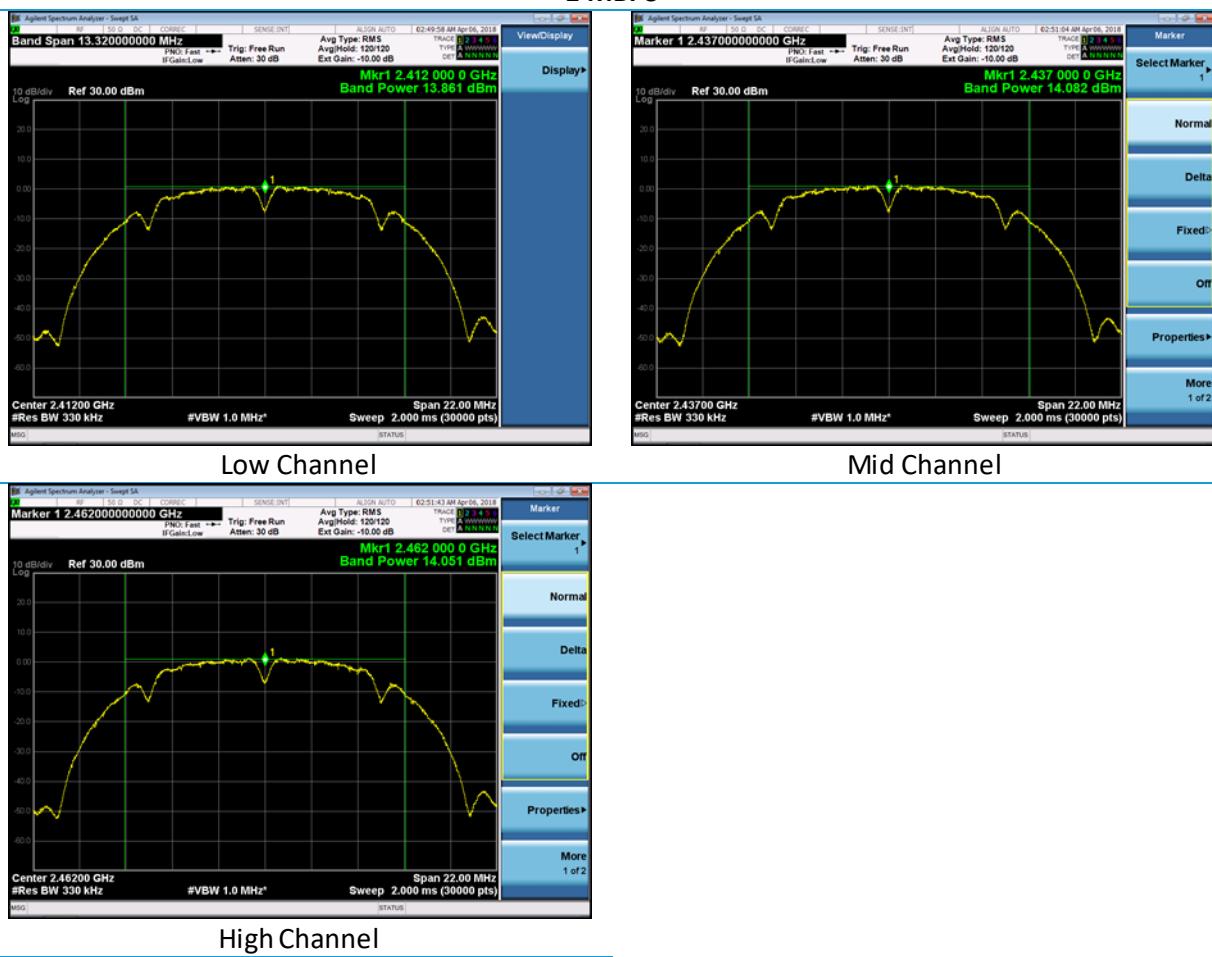
6 MBPS Off Time



MCS0 Off Time

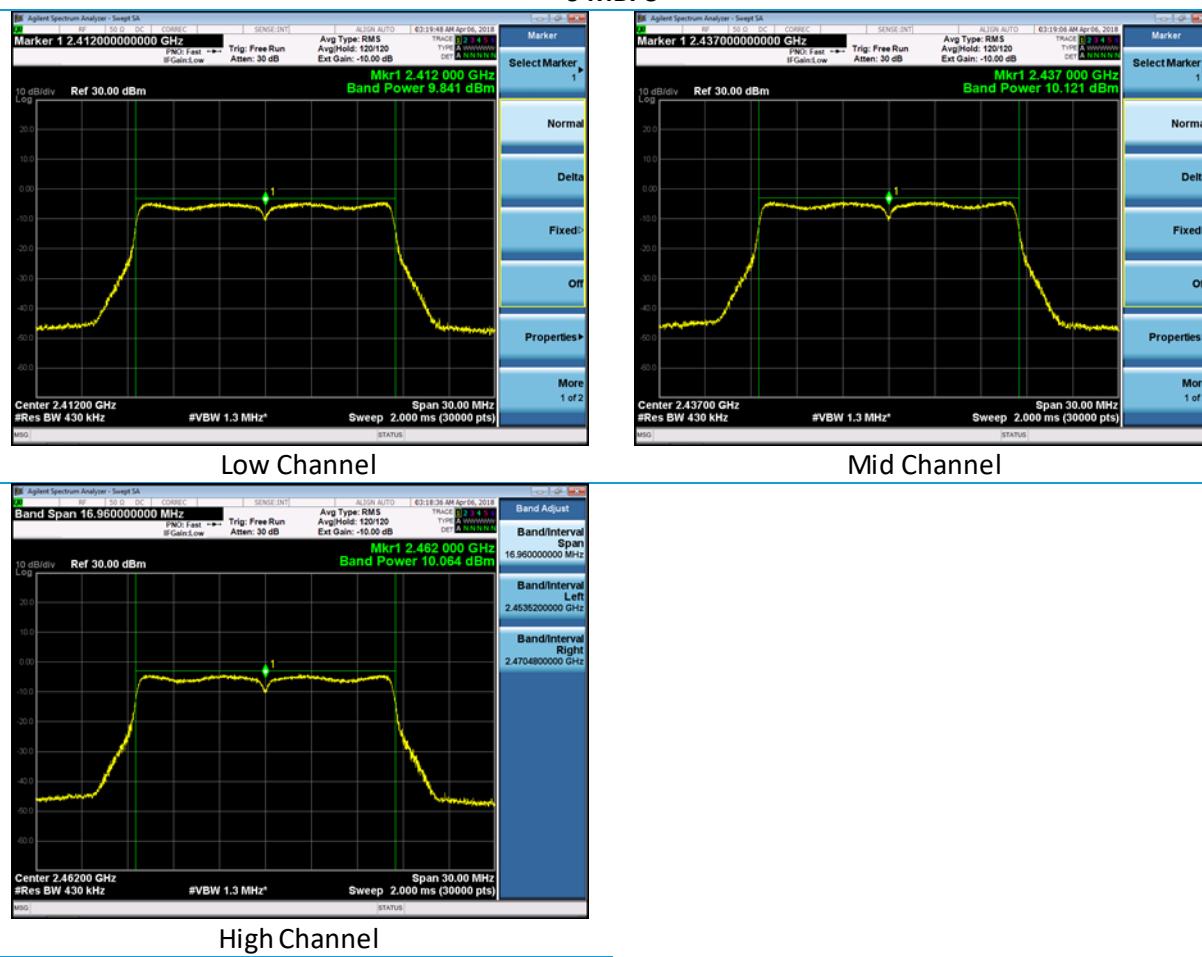
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## 1 MBPS



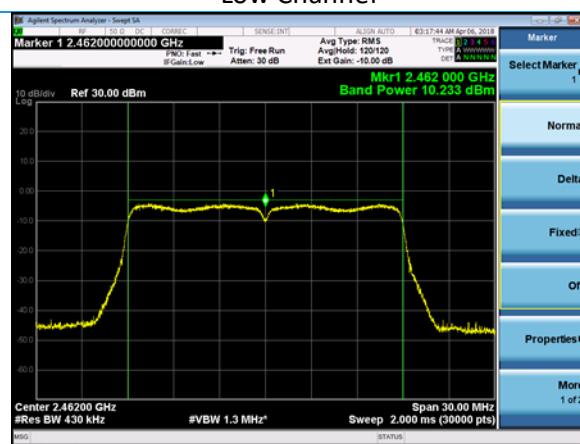
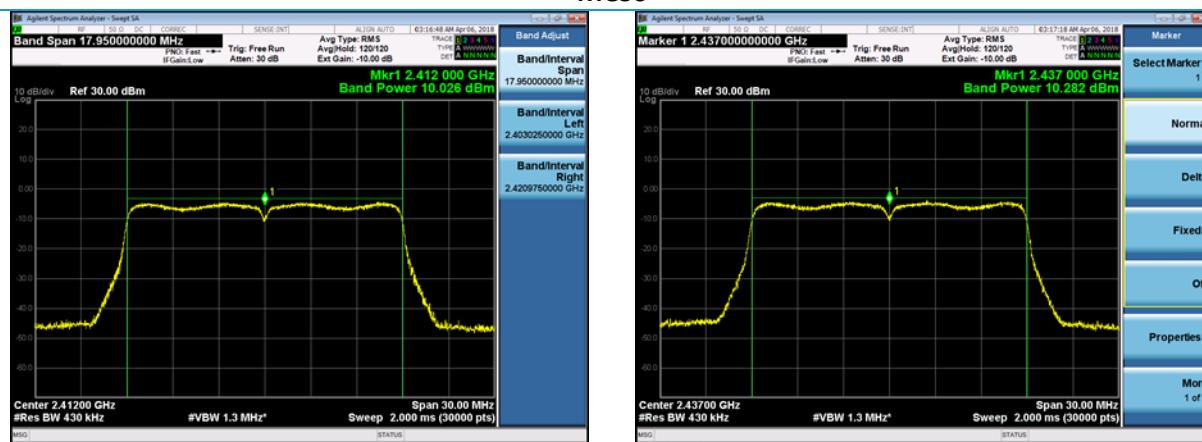
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## 6 MBPS



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## MCS0



High Channel

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## 6 EXCLUSION CALCULATION

### 6.1 FCC

Output Power (dBm) = Measured Value (dBm) + Tune-up Tolerance (dB)

BLE Output Power = 8.78 dBm + 3.0 dB = 11.78 dBm = 15 mW

Per FCC KDB 447498 Section 4.3.1 a):

Min separation distance (mm) = Maximum Output power (mW) \*  $\sqrt{f(\text{GHz})} / 3.0$

= 15 mW \*  $\sqrt{2.402} / 3.0$

= 8 mm

Therefore, the EUT is exempt from SAR testing for all separation distances greater than 8 mm.

WLAN Output Power = 14.08 dBm + 3.0 dB = 17.08 dBm = 51 mW

Per FCC KDB 447498 Section 4.3.1 a):

Min separation distance (mm) = Maximum Output power (mW) \*  $\sqrt{f(\text{GHz})} / 3.0$

= 44 mW \*  $\sqrt{2.437} / 3.0$

= 27 mm

Therefore, the EUT is exempt from SAR testing for all separation distances greater than 27 mm.

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## 6.2 ISED Canada

Compliance determined with RSS-102 Section 2.5.1 Table 1. 3 dB tune-up tolerance included in output power measurements.

**Table 1: SAR evaluation – Exemption limits for routine evaluation based on frequency and separation distance<sup>4,5</sup>**

Frequency (MHz)	Exemption Limits (mW)				
	At separation distance of 5 mm	At separation distance of 10 mm	At separation distance of 15 mm	At separation distance of 20 mm	At separation distance of 25 mm
≤300	71 mW	101 mW	132 mW	162 mW	193 mW
450	52 mW	70 mW	88 mW	106 mW	123 mW
835	17 mW	30 mW	42 mW	55 mW	67 mW
1900	7 mW	10 mW	18 mW	34 mW	60 mW
2450	4 mW	7 mW	15 mW	30 mW	52 mW
3500	2 mW	6 mW	16 mW	32 mW	55 mW
5800	1 mW	6 mW	15 mW	27 mW	41 mW

Frequency (MHz)	Exemption Limits (mW)				
	At separation distance of 30 mm	At separation distance of 35 mm	At separation distance of 40 mm	At separation distance of 45 mm	At separation distance of ≥50 mm
≤300	223 mW	254 mW	284 mW	315 mW	345 mW
450	141 mW	159 mW	177 mW	195 mW	213 mW
835	80 mW	92 mW	105 mW	117 mW	130 mW
1900	99 mW	153 mW	225 mW	316 mW	431 mW
2450	83 mW	123 mW	173 mW	235 mW	309 mW
3500	86 mW	124 mW	170 mW	225 mW	290 mW
5800	56 mW	71 mW	85 mW	97 mW	106 mW

### BLE

For 2402 MHz, the exemption limit is 30 mW at 20 mm.

Since 17 mW < 30 mW, the EUT is exempt from routine SAR evaluation at 20 mm.

### WLAN

For 2437 MHz, the exemption limit is 124 mW at 35 mm.

Since 87 mW < 124 mW, the EUT is exempt from routine SAR evaluation at 35 mm.

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## 7 REVISION HISTORY

Version	Date	Notes	Person
V0	3/6/18	First Draft	Shane Dock
V1	4/24/18	Updated Draft	Shane Dock
V2	4/25/18	Final Draft	Shane Dock
V3	7/11/18	More Revisions	Shane Dock
V4	2/6/19	Further revisions	Shane Dock
V5	4/9/19	Calculation corrections	Shane Dock

**END OF REPORT**

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