

Test Report # 318219 B

Equipment Under Test: DTV Konnect Module

Test Date(s): 10/28/18 - 11/29/18

Prepared for: ATTN: Tim Stessman
Codes & Standards
Kohler Co., Kitchen and Bath Americas
444 Highland Drive
Kohler, WI 53044

Report Issued by: Shane Dock, EMC Engineer

Signature:



Date: 12/17/2018

Report Reviewed by: Adam Alger, Quality Manager

Signature:



Date: 12/12/2018

Report Constructed by: Shane Dock, EMC Engineer

Signature:



Date: 12/17/2018

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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



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

Company: Kohler Co.	Page 3 of 18	Name: DTV Konnect Module
Report: 318219B		Model: K-97999-NA
Job: C-3047		Serial: 02

1 TEST REPORT SUMMARY

During **12/10/18** the Equipment Under Test (EUT), **DTV Konnect Module**, as provided by **Kohler Co.** 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.

2 CLIENT INFORMATION

Company Name	Kohler Co.
Contact Person	Tim Stessman
Address	444 Highland Drive Kohler, WI 53044

2.1 Equipment Under Test (EUT) Information

The following information has been supplied by the client

Product Name	DTV Plus
Model Number	K-97999-NA
Serial Number	02
FCC / IC ID	FCC ID: N82-KOHLER029 IC ID: 4554A-KOHLER029

2.2 Product Description

DTV Konnect Module is comprised of a circuit board containing a 2.4 GHz Wi-Fi module. Circuit board is mounted within a plastic enclosure containing an internal, off-board antenna. A single cable provides power and communications from a host DTV+ Controller unit. The DTV Konnect Module provides cloud connectivity for the DTV+ Shower System to enable mobile app and voice control of showering functions.

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

EUT provided with 12VDC power via controller. EUT programmed via serial connection with PuTTY (Texas Instruments Calibrator commands was used to set channel, power, and mode). Antenna used is a Laird 2.4 GHz FlexPIFA Antenna w/ u.FL Cable, 100 mm with a 2 dBi peak gain.

2.6 WLAN Information

Unit tested with an ini file provided by customer. The unit was tested at 2412 MHz, 2437 MHz, and 2462 MHz (Low, Mid, and High). For HT40, the EUT was tested at 2422, 2432 and 2442 MHz (labeled Low, Mid, and High). The HT40 MCS0 data rate was also tested at 2437 MHz, as the high channel has a reduced power.

3 REFERENCES

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

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

5.1.1 Antenna Port Conducted Emissions – Conducted Output Power

Operator	Shane Dock
Test Date	11/2/18 – 11/8/18
Location	Conducted RF Area
Temp. / R.H.	70 degrees F/ 23% RH
Requirement	FCC: 15.247 (b)(3) IC: RSS-247 5.4 (4)
Method	ANSI C63.10 Section 11.9.2.2.4

Limits: (Measured as Average)

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

Test Parameters

Frequency	2412-2462 MHz
Settings	Low, Mid, and High Channels Measured
Notes	All power values corrected by $10 \log(1/x)$, where x is the duty cycle expressed as a decimal between 0 and 1. For example, with a duty cycle of 87%, this would be a correction of $10 \log(1/0.87)$.

Table

1 MBPS

Channel	Low	Mid	High
Output Power (dBm)	13.2	13.3	13.9
Duty Cycle (%)	91.6	91.6	91.6
Corrected Output Power (dBm)	13.6	13.7	14.3

6 MBPS

Channel	Low	Mid	High
Output Power (dBm)	9.3	13.4	10.6
Duty Cycle (%)	96.0	96.0	96.0
Corrected Output Power (dBm)	9.5	13.6	10.8

MCS0

Channel	Low	Mid	High
Output Power (dBm)	10.2	14.3	10.8
Duty Cycle (%)	93.7	93.7	93.7
Corrected Output Power (dBm)	10.5	14.6	11.1

11 MBPS

Channel	Low	Mid	High
Output Power (dBm)	11.5	12.6	12.9
Duty Cycle (%)	73.3	73.3	73.3
Corrected Output Power (dBm)	12.8	13.9	14.2

54 MBPS

Channel	Low	Mid	High
Output Power (dBm)	5.5	6.2	6.2
Duty Cycle (%)	57.6	57.6	57.6
Corrected Output Power (dBm)	7.9	8.6	8.6

MCS7

Channel	Low	Mid	High
Output Power (dBm)	5.5	6.2	6.2
Duty Cycle (%)	32.1	32.1	32.1
Corrected Output Power (dBm)	10.4	11.1	11.1

HT40 MCS0

Channel	Low	Mid	2437 MHz	High
Output Power (dBm)	6.4	10.8	11.1	8.3
Duty Cycle (%)	60.5	60.5	60.5	60.5
Corrected Output Power (dBm)	8.6	13.0	13.3	10.5

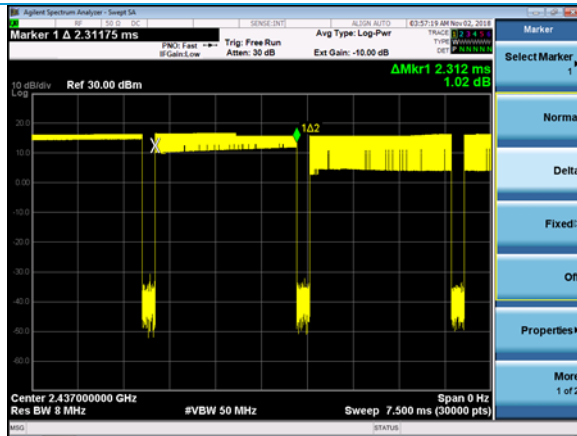
HT40 MCS7

Channel	Low	Mid	High
Output Power (dBm)	2.2	3.4	3.3
Duty Cycle (%)	24.3	24.3	24.3
Corrected Output Power (dBm)	8.3	9.5	9.4

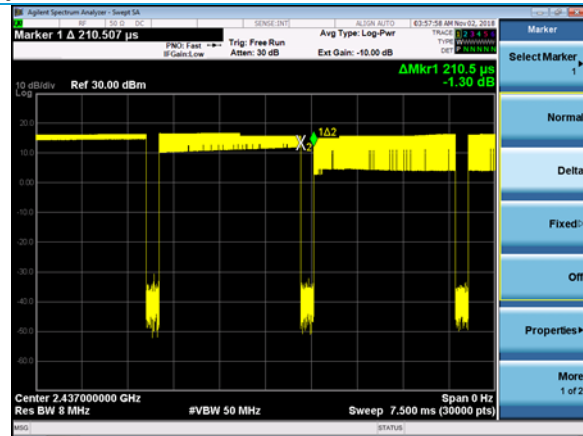
Worst Case Margin = Limit - Closest Measurement = 30.0 dBm – 14.6 dBm = 15.4 dB

Plots begin on the next page.

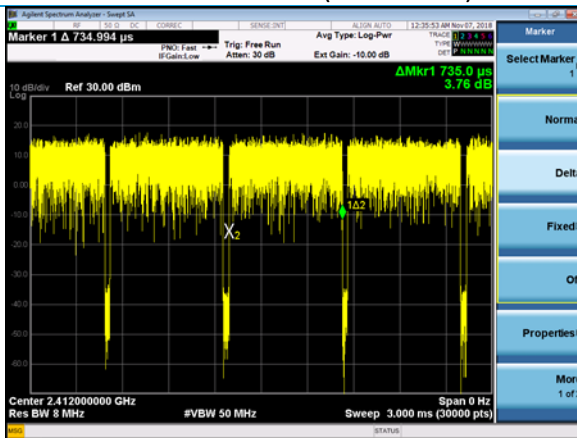
Duty Cycle



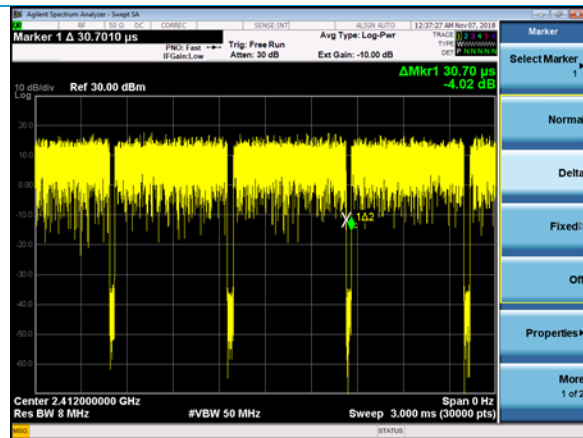
1 MBPS On Time (DC = 91.6%)



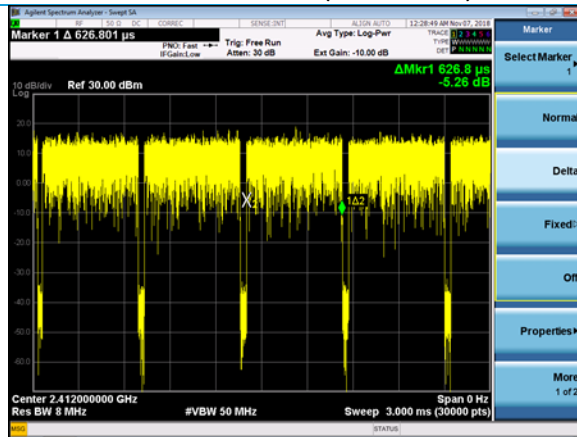
1 MBPS Off Time



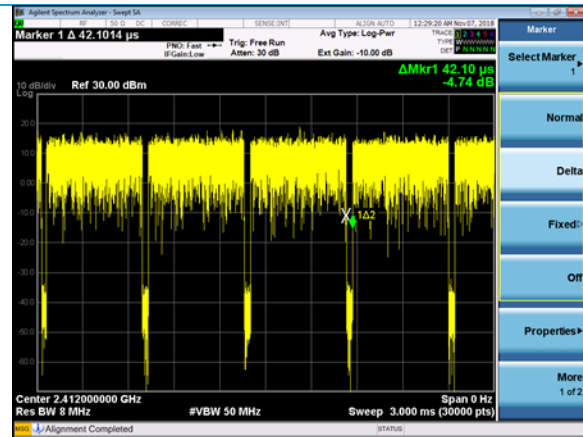
6 MBPS On Time (DC = 96.0%)



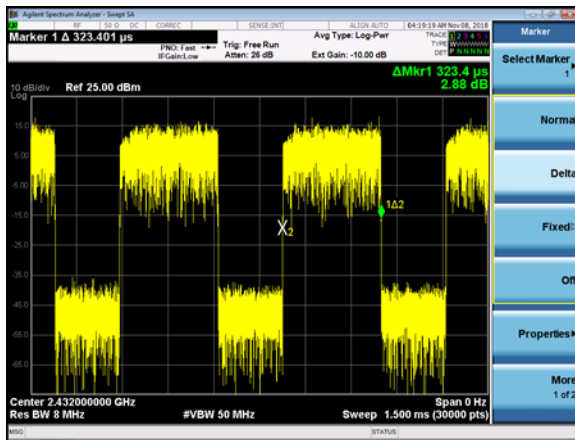
6 MBPS Off Time



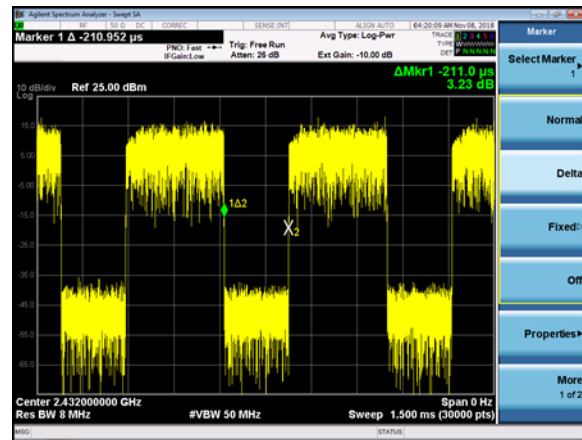
MCS0 On Time (DC = 93.7%)



MCS0 Off Time

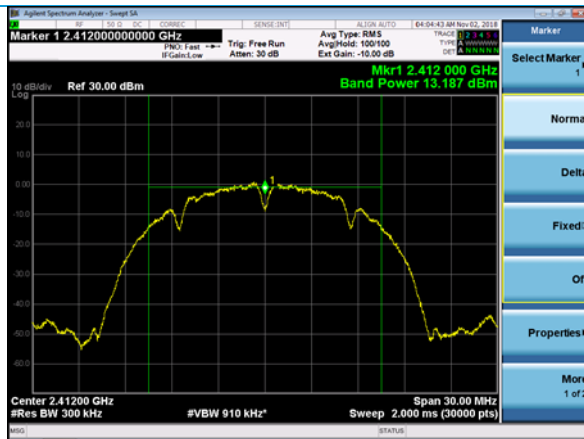


HT40 MCS0 On Time (DC = 60.5%)

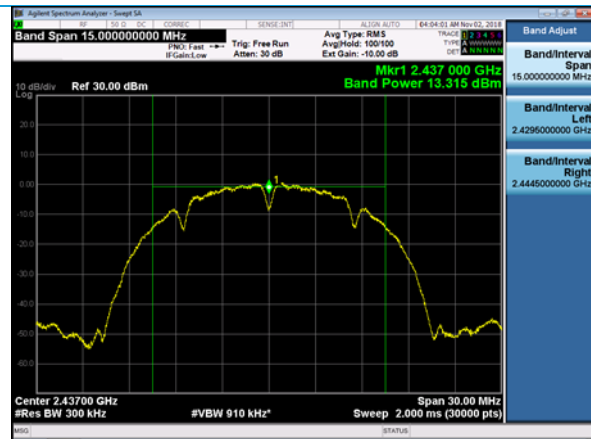


HT40 MCS0 Off Time

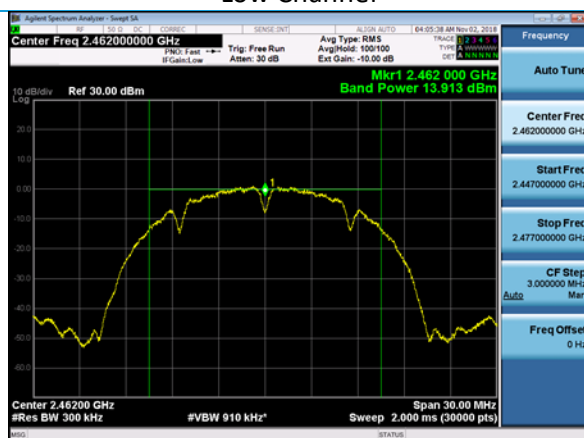
1 MBPS



Low Channel

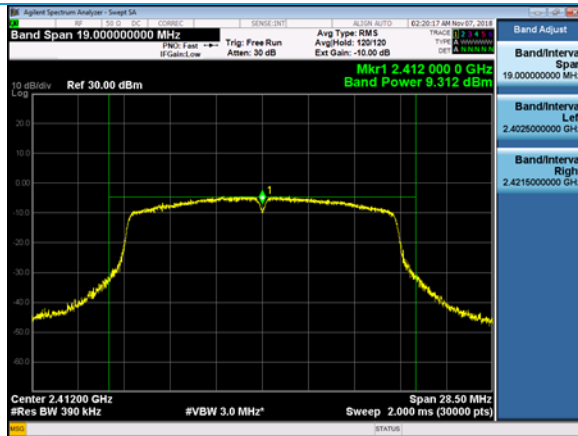


Mid Channel

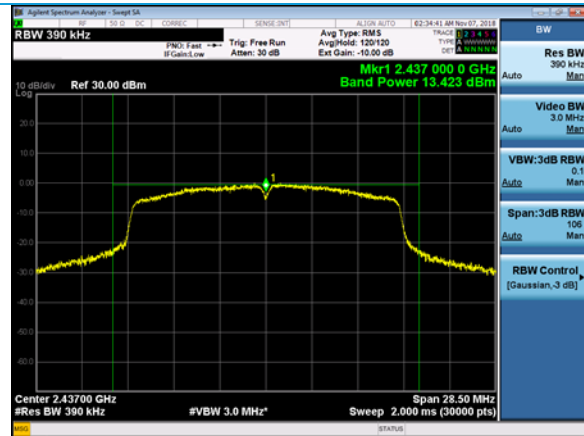


High Channel

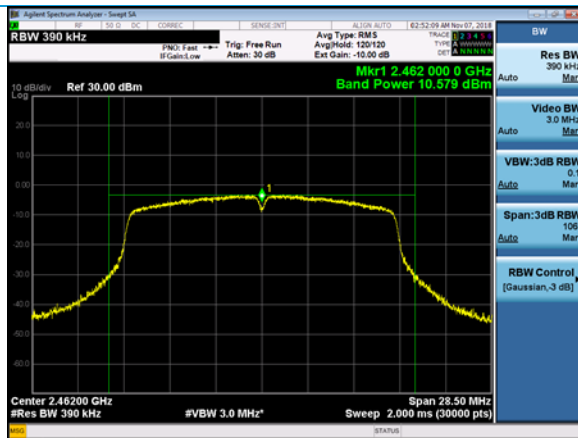
6 MBPS



Low Channel

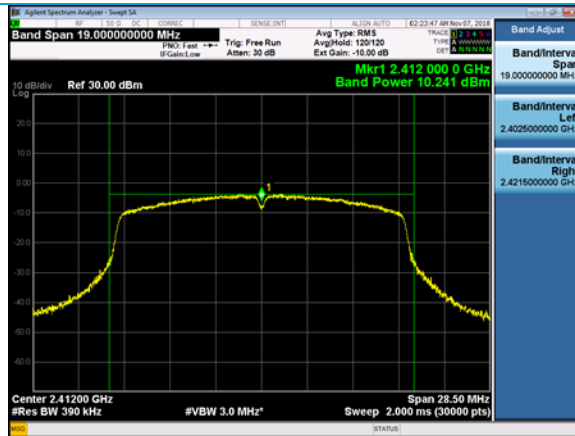


Mid Channel

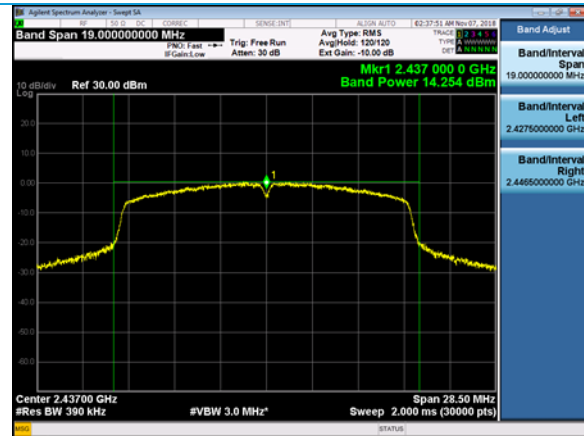


High Channel

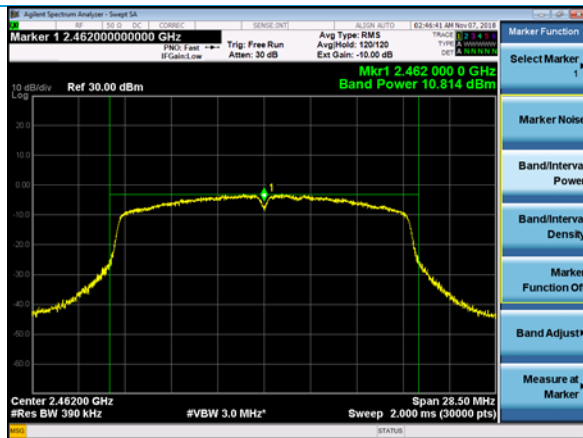
MCS0



Low Channel

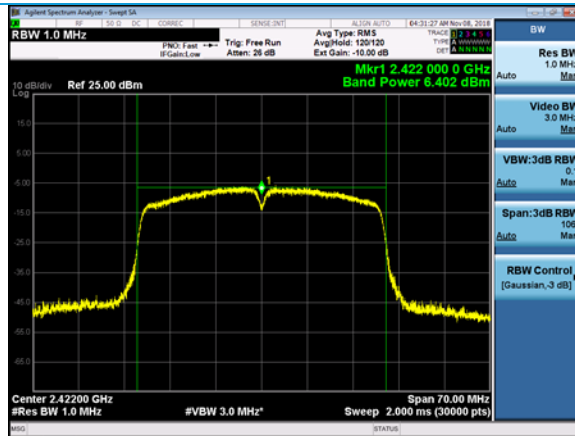


Mid Channel

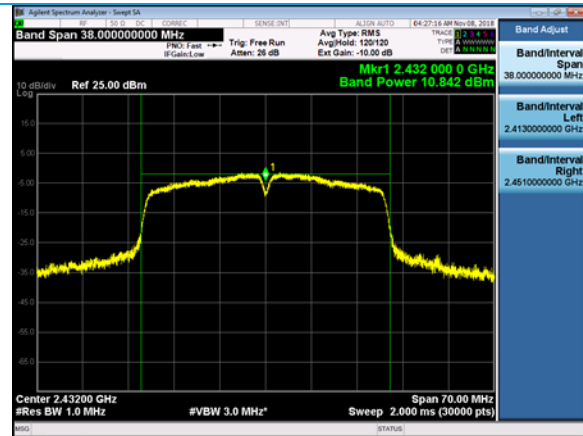


High Channel

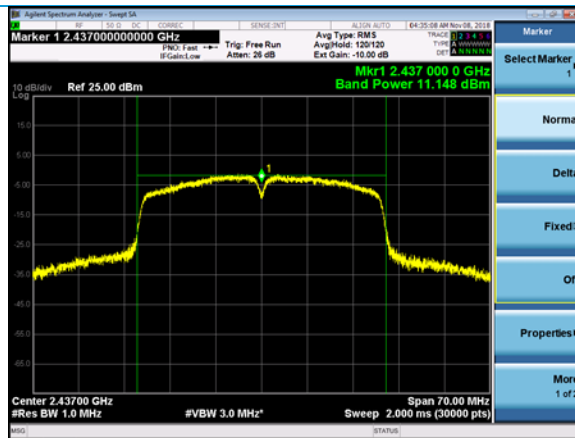
HT40 MCS0



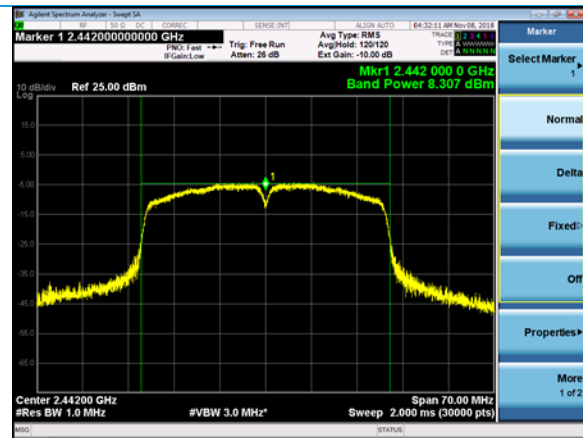
Low Channel



Mid Channel



2437 MHz



High Channel

6 EXCLUSION CALCULATION

6.1 FCC

Compliance to 2.1091 is to be demonstrated via MPE calculations.

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

WLAN Output Power = 14.6 dBm + 2.0 dBi + 1.5 dB = 18.1 dBm = 64.6 mW

Equation from page 18 of OET Bulletin 65, Edition 97-01

$$S = \frac{PG}{4\pi R^2}$$

where: S = power density

P = power input to the antenna

G = power gain of the antenna in the direction of interest relative to an isotropic radiator

R = distance to the center of radiation of the antenna

Maximum peak output power at antenna input terminal: 16.10 (dBm)

Maximum peak output power at antenna input terminal: 40.738 (mW)

Antenna gain(peak): 2 (dBi)

Maximum antenna gain: 1.585 (numeric)

Prediction distance: 20 (cm)

Prediction frequency: 2437 (MHz)

MPE limit for uncontrolled exposure at prediction frequency: 1 (mW/cm²)

Power density at prediction frequency: 0.012845 (mW/cm²)

As the power density value is lower than the MPE limit at the prediction frequency, the unit is excluded from routine SAR testing.

6.2 ISED Canada

Per RSS-102 Section 2.5.2:

- at or above 300 MHz and below 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $1.31 \times 10^{-2} f^{0.6834}$ W (adjusted for tune-up tolerance), where f is in MHz;

WLAN

For 2437 MHz, the Exemption Limit is $.0131 * f(\text{MHz})^{0.6834} = 2.7 \text{ W}$

Since $64.6 \text{ mW} < 2.7 \text{ W}$, the EUT is exempt from routine SAR evaluation.

7 REVISION HISTORY

Version	Date	Notes	Person
V0	12/10/18	First Draft	Shane Dock
V1	12/17/18	Final draft	Shane Dock
V2	5/1/19	Further Update	Shane Dock

END OF REPORT