



# TEST REPORT


**Test Report No. :** UL-RPT-RP13337971-1416A V4.0

**Customer** : Raspberry Pi (Trading) Ltd  
**Model No. / PMN** : Raspberry Pi RM0  
**HVIN** : Raspberry Pi RM0  
**FCC ID** : 2ABCB-RPIRM0  
**ISED Certification No.** : IC: 20953-RPIRM0  
**Technology** : WLAN  
**Test Standard(s)** : FCC Parts 15.247(a)(2), 15.247(e), 15.247(b)(3) & 15.247(d)  
Innovation, Science and Economic Development Canada  
RSS-247 Issue 2 Sections 5.2(a), 5.2(b) & 5.4(d) & 5.5  
RSS-Gen Issue 5 Sections 6.7, 6.12 & 8.2  
**Test Laboratory** : UL International (UK) Ltd, Basingstoke, Hampshire, RG24 8AH,  
United Kingdom

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2. The results in this report apply only to the sample(s) tested.
3. The sample tested is in compliance with the above standard(s).
4. The test results in this report are traceable to the national or international standards.
5. Version 4.0 supersedes all previous versions.

**Date of Issue:** 05 November 2020

**Checked by:**   
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**Company Signatory:**   
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## **Customer Information**

<b>Company Name:</b>	Raspberry Pi (Trading) Ltd
<b>Address:</b>	Maurice Wilkes Building Cowley Road Cambridge CB4 0DS United Kingdom

## **Report Revision History**

<b>Version Number</b>	<b>Issue Date</b>	<b>Revision Details</b>	<b>Revised By</b>
1.0	02/07/2020	Initial Version	Sarah Williams
2.0	20/10/2020	Re-test of 40 MHz channel bandwidth tests	Sarah Williams
3.0	30/10/2020	Lower Band Edge results added	Ben Mercer
4.0	05/11/2020	PMN/HVIN updated	Sarah Williams

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## 1. Attestation of Test Results

### 1.1. Description of EUT

The equipment under test was a *Bluetooth* and WiFi radio module.

### 1.2. General Information

<b>Specification Reference:</b>	47CFR15.247
<b>Specification Title:</b>	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) - Section 15.247
<b>Specification Reference:</b>	RSS-Gen Issue 5 March 2019
<b>Specification Title:</b>	General Requirements for Compliance of Radio Apparatus
<b>Specification Reference:</b>	RSS-247 Issue 2 February 2017
<b>Specification Title:</b>	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices
<b>Site Registration:</b>	FCC: 621311, ISEDC: 20903
<b>Location of Testing:</b>	Unit 3 Horizon, Wade Road, Kingsland Business Park, Basingstoke, Hampshire, RG24 8AH, United Kingdom
<b>Test Dates:</b>	11 June 2020 to 28 October 2020

### 1.3. Summary of Test Results

FCC Reference (47CFR)	ISED Canada Reference	Measurement	Result
Part 15.35(c)	RSS-Gen 8.2	Transmitter Duty Cycle	Note 1
N/A	RSS-Gen 6.7	Transmitter 99% Occupied Bandwidth	✔
Part 15.247(a)(2)	RSS-Gen 6.7 / RSS-247 5.2(a)	Transmitter Minimum 6 dB Bandwidth	✔
Part 15.247(e)	RSS-247 5.2(b)	Transmitter Power Spectral Density	✔
Part 15.247(b)(3)	RSS-Gen 6.12 / RSS-247 5.4(d)	Transmitter Maximum (Average) Output Power	✔
Part 15.247(d) & 15.209(a)	RSS-Gen 6.13 / RSS- 247 5.5	Transmitter Band Edge Conducted Emissions	✔
<b>Key to Results</b>			
✔ = Complied    ✘ = Did not comply			

#### Note(s):

- The measurement was performed to assist in the calculation of the level of maximum conducted output power, power spectral density and emissions. The EUT cannot transmit continuously and sweep triggering/signal gating cannot be implemented.
- For the data rates declared as worst case and reported in this test report, duty cycle was measured to be greater than 98%. Plots for these measurements are archived on the UL International (UK) Ltd IT server and available for inspection upon request.

#### **1.4. Deviations from the Test Specification**

For the measurements contained within this test report, there were no deviations from, additions to, or exclusions from the test specification identified above.

## **2. Summary of Testing**

### **2.1. Facilities and Accreditation**

The test site and measurement facilities used to collect data are located at Unit 3 Horizon, Wade Road, Kingsland Business Park, Basingstoke, Hampshire, RG24 8AH, United Kingdom.

UL International (UK) Ltd is accredited by UKAS. The tests reported herein have been performed in accordance with its terms of accreditation.

### **2.2. Methods and Procedures**

<b>Reference:</b>	ANSI C63.10-2013
<b>Title:</b>	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
<b>Reference:</b>	KDB 558074 D01 15.247 Meas Guidance v05r02, April 2, 2019
<b>Title:</b>	Guidance for Compliance Measurements on Digital Transmission System, Frequency Hopping Spread Spectrum System, and Hybrid System Devices Operating Under Section 15.247 of the FCC Rules

## **2.3. Calibration and Uncertainty**

### **Measuring Instrument Calibration**

In accordance with UKAS requirements all the measurement equipment is on a calibration schedule. All equipment was within the calibration period on the date of testing.

### **Measurement Uncertainty**

No measurement or test can ever be perfect and the imperfections give rise to error of measurement in the results. Consequently the result of a measurement is only an approximation to the value measured (the specific quantity subject to measurement) and is only complete when accompanied by a statement of the uncertainty of the approximation.

The expression of uncertainty of a measurement result allows realistic comparison of results with reference values and limits given in specifications and standards.

The uncertainty of the result may need to be taken into account when interpreting the measurement results.

The reported expanded uncertainties below are based on a standard uncertainty multiplied by an appropriate coverage factor such that a confidence level of approximately 95% is maintained. For the purposes of this document “approximately” is interpreted as meaning “effectively” or “for most practical purposes”.

<b>Measurement Type</b>	<b>Range</b>	<b>Confidence Level (%)</b>	<b>Calculated Uncertainty</b>
Duty Cycle	2.4 GHz to 2.4835 GHz	95%	±1.14 %
99% Emission Bandwidth	2.4 GHz to 2.4835 GHz	95%	±4.59 %
Minimum 6 dB Bandwidth	2.4 GHz to 2.4835 GHz	95%	±4.59 %
Spectral Power Density	2.4 GHz to 2.4835 GHz	95%	±1.13 dB
Conducted Maximum Output Power	2.4 GHz to 2.4835 GHz	95%	±1.13 dB
Conducted Band Edge Emissions	2.4 GHz to 2.4835 GHz	95%	±2.62 dB

The methods used to calculate the above uncertainties are in line with those recommended within the various measurement specifications. Where measurement specifications do not include guidelines for the evaluation of measurement uncertainty the published guidance of the appropriate accreditation body is followed.

## **2.4. Test and Measurement Equipment**

### **Test Equipment Used for Transmitter Conducted Tests**

<b>Asset No.</b>	<b>Instrument</b>	<b>Manufacturer</b>	<b>Type No.</b>	<b>Serial No.</b>	<b>Date Calibration Due</b>	<b>Cal. Interval (Months)</b>
M2004	Thermohygrometer	Testo	608-H1	45046425	05 Jan 2021	12
M2033	Signal Analyser	Rohde & Schwarz	FSV13	101667	24 Jul 2020	12
M2036	Signal Analyser	Rohde & Schwarz	FSV30	101791	18 May 2021	12
M2022	Power Sensor	Boonton	55006	9968	20 Jan 2021	12
A3027	Attenuator	Broadwave Technologies Inc.	351-311-006	#1	Calibrated before use	-
A3004	RF Switch	Pickering Interfaces	64-102-002	XZ363230	Calibrated before use	-
A3180	Attenuator	Pasternack	PE7047-3	Not stated	Calibrated before use	-
G0607	Signal Generator	Rohde & Schwarz	SMU200A	100943	12 Jun 2022	36
G0614	Signal Generator	Rohde & Schwarz	SMB100A	260473	19 May 2023	36
A3005	Replay Test Rack	N/A	N/A	N/A	Calibration not required	-
M2001	Thermohygrometer	Testo	608-H1	45041824	05 Jan 2021	12
M1886	Test Receiver	Rohde & Schwarz	ESU26	1000554	15 May 2021	12
G0628	Vector Signal generator	Rohde & Schwarz	SMBV100A	261847	08 October 2023	36
A2527	Attenuator	AltanTechRF	AN18W5-20	832828#2	Calibrated before use	-

### **Test Measurement Software/Firmware Used for Transmitter Conducted Tests**

<b>Name</b>	<b>Version</b>	<b>Release Date</b>
UL VS LTD Replay	20190208	08 February 2019



### **3. Equipment Under Test (EUT)**

#### **3.1. Identification of Equipment Under Test (EUT)**

<b>Brand Name:</b>	Raspberry Pi
<b>Model Name or Number / PMN:</b>	Raspberry Pi RM0
<b>Test Sample Serial Number:</b>	3103753 ( <i>Conducted sample #1</i> )
<b>Hardware Version:</b>	V1.0
<b>Software Version:</b>	V1.0
<b>FCC ID:</b>	2ABCB-RPIRM0
<b>ISED Canada Certification Number:</b>	IC: 20953-RPIRM0

<b>Brand Name:</b>	Raspberry Pi
<b>Model Name or Number / PMN:</b>	Raspberry Pi RM0
<b>Test Sample Serial Number:</b>	3157589 ( <i>Conducted sample #2</i> )
<b>Hardware Version:</b>	V1.0
<b>Software Version:</b>	V1.0
<b>FCC ID:</b>	2ABCB-RPIRM0
<b>ISED Canada Certification Number:</b>	IC: 20953-RPIRM0

<b>Brand Name:</b>	Raspberry Pi
<b>Model Name or Number / PMN:</b>	Raspberry Pi RM0
<b>Test Sample Serial Number:</b>	3185953 ( <i>Conducted sample #3</i> )
<b>Hardware Version:</b>	V1.0
<b>Software Version:</b>	V1.0
<b>FCC ID:</b>	2ABCB-RPIRM0
<b>ISED Canada Certification Number:</b>	IC: 20953-RPIRM0

#### **3.2. Modifications Incorporated in the EUT**

No modifications were applied to the EUT during testing.

### **3.3. Additional Information Related to Testing**

<b>Technology Tested:</b>	WLAN (IEEE 802.11b,g,n) / Digital Transmission System		
<b>Type of Unit:</b>	Transceiver		
<b>Modulation Type:</b>	DBPSK, DQPSK, BPSK, QPSK, 16QAM & 64QAM		
<b>Data Rates:</b>	802.11b	1, 2, 5.5 & 11 Mbps (SISO)	
	802.11g	6, 9, 12, 18, 24, 36, 48 & 54 Mbps (SISO)	
	802.11n HT20	MCS0 to MCS7 (SISO)	
	802.11n HT40	MCS0 to MCS7 (SISO)	
<b>Power Supply Requirement(s):</b>	Nominal	5.0 VDC	
<b>Maximum Conducted Output Power:</b>	15.4 dBm		
<b>Channel Bandwidth:</b>	20 MHz		
<b>Transmit Frequency Range:</b>	2412 MHz to 2462 MHz		
<b>Transmit Channels Tested:</b>	<b>Channel ID</b>	<b>Channel Number</b>	<b>Channel Frequency (MHz)</b>
	Bottom	1	2412
	Middle	6	2437
	Top	11	2462
<b>Channel Bandwidth:</b>	40 MHz		
<b>Transmit Frequency Range:</b>	2422 MHz to 2452 MHz		
<b>Transmit Channels Tested:</b>	<b>Channel ID</b>	<b>Channel Number</b>	<b>Channel Frequency (MHz)</b>
	Bottom	3	2422
	Top	9	2452

### **3.4. Description of Available Antennas**

The table below lists the internal niche antenna and the external antenna available.

<b>Manufacturer</b>	<b>Type</b>	<b>Frequency Range (MHz)</b>	<b>Antenna Gain (dBi)</b>
ProAnt	Internal	2400 to 2480	3.5
Raspberry Pi	External	2400 to 2480	2.0

### **3.5. Description of Test Setup**

#### **Support Equipment**

The following support equipment was used to exercise the EUT during testing:

<b>Description:</b>	Pi4 board used as test jig ( <i>conducted sample #1</i> )
<b>Brand Name:</b>	Raspberry Pi4
<b>Model Name or Number:</b>	Pi4
<b>Serial Number:</b>	100000005C55D5A9

<b>Description:</b>	Pi4 board used as test jig ( <i>conducted sample #2</i> )
<b>Brand Name:</b>	Raspberry Pi4
<b>Model Name or Number:</b>	Pi4
<b>Serial Number:</b>	10000000ae575e0

<b>Description:</b>	Micro SD Card with OS image
<b>Brand Name:</b>	SanDisk
<b>Model Name or Number:</b>	16 GB card
<b>Serial Number:</b>	Not marked or stated

<b>Description:</b>	USB Mouse
<b>Brand Name:</b>	Raspberry Pi
<b>Model Name or Number:</b>	RPI-MOUSE
<b>Serial Number:</b>	Not marked or stated

<b>Description:</b>	USB Keyboard
<b>Brand Name:</b>	Raspberry Pi
<b>Model Name or Number:</b>	RPI-KYB
<b>Serial Number:</b>	Not marked or stated

<b>Description:</b>	USB Keyboard
<b>Brand Name:</b>	HP
<b>Model Name or Number:</b>	KU-0316
<b>Serial Number:</b>	Not marked or stated

<b>Description:</b>	Power Supply. 100-230 VAC Input / 5 VDC Output
<b>Brand Name:</b>	Belkin
<b>Model Name or Number:</b>	Not marked or stated
<b>Serial Number:</b>	Not marked or stated

## **Operating Modes**

The EUT was tested in the following operating mode(s):

- Continuously transmitting with a modulated carrier at maximum power on the relevant channels as required using the supported data rates/modulation types.

## **Configuration and Peripherals**

The EUT was tested in the following configuration(s):

- The customer supplied 'wl' chipset commands. Test commands were provided in the wlan\_testing.sh file located on the /home/pi drive of the EUT. The test commands were entered into the automated test system and used to configure the EUT to enable a continuous transmission and to select the test channels, data rates and modulation schemes as required.
- The customer declared the following data rates to be used for all measurements as:
  - 802.11b – DBPSK / 1 Mbps
  - 802.11g – BPSK / 6 Mbps
  - 802.11n HT20 – BPSK / MCS0
  - 802.11n HT40 – BPSK / MCS0
- Testing was performed using the customer declared power settings:
  - 802.11b – 1 Mbps / Q values: CH1: 52, CH6: 52 and CH11: 51
  - 802.11g – 6 Mbps / Q values: CH1: 57, CH6: 57 and CH11: 42
  - 802.11n HT20 – MCS0 / Q values: CH1: 58, CH6: 58 and CH11: 38
  - 802.11n HT40 – MCS0 / Q values: CH1: 56 and CH7: 56
- The following power settings were reduced to achieve compliant band edge results:
  - 802.11g – 6 Mbps / Q values: CH1: 56
  - 802.11n HT20 – MCS0 / Q values: CH1: 56

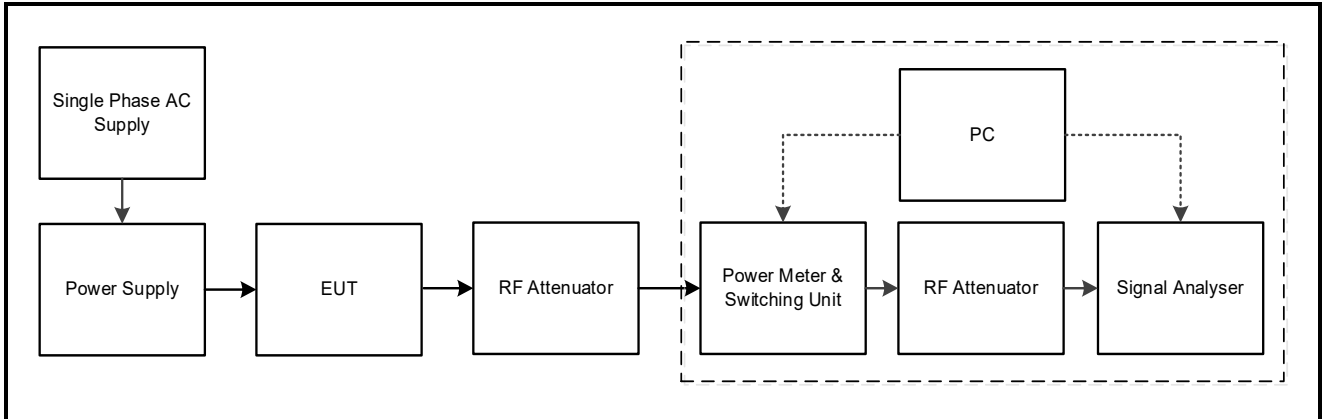
All other test results for these modes were tested at the higher power settings stated above, representing worst case results.

- The EUT was powered via the Pi4 test jig which was powered from an AC/DC switch mode power supply.
- The EUT with serial number 3103753 was used for 20 MHz channel bandwidth tests and serial number 3157589 was used for 40 MHz channel bandwidth tests.

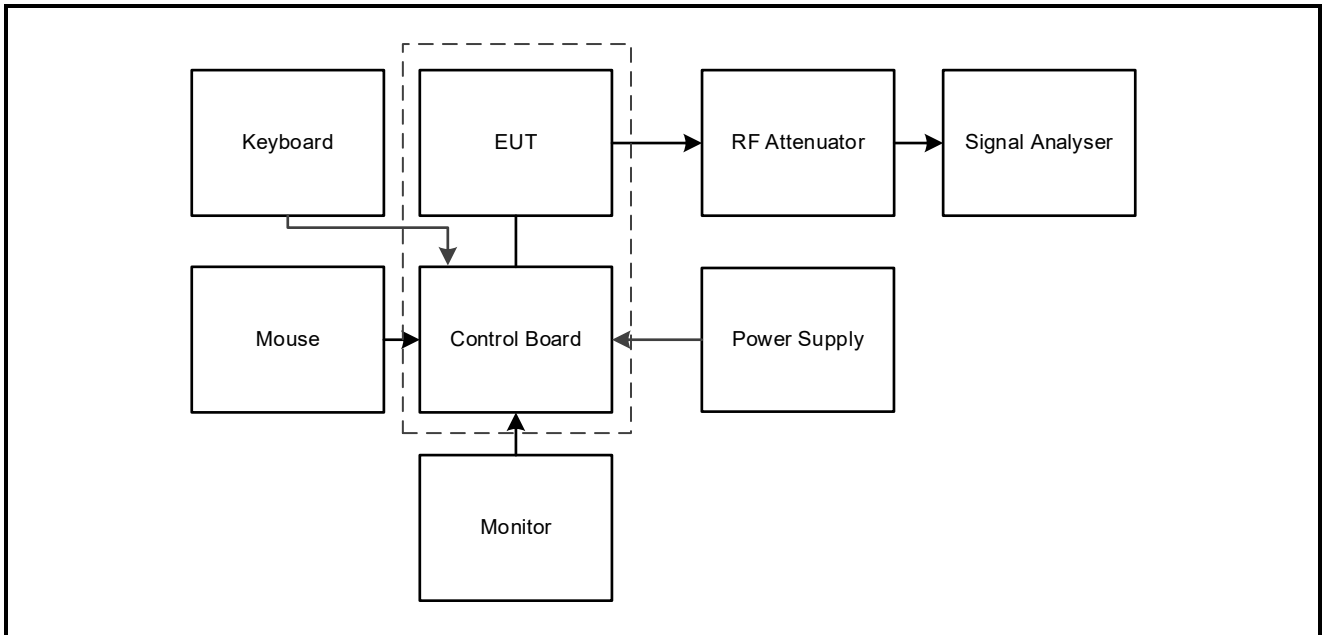
**Test Setup Diagrams**

**Conducted Tests:**

**Test Setup for Transmitter Conducted Tests**



**Test Setup for Transmitter band Edge Conducted Emissions**



## **4. Antenna Port Test Results**

### **4.1. Transmitter Duty Cycle**

#### **Test Summary:**

<b>Test Engineer:</b>	Max Passell	<b>Test Date:</b>	16 October 2020
<b>Test Sample Serial Number:</b>	3157589		

<b>FCC Reference:</b>	Part 15.35(c)
<b>ISED Canada Reference:</b>	RSS-Gen 8.2
<b>Test Method Used:</b>	FCC KDB 558074 Section 6 referencing ANSI C63.10 Section 11.6

#### **Environmental Conditions:**

<b>Temperature (°C):</b>	26
<b>Relative Humidity (%):</b>	33

#### **Note(s):**

1. In order to assist with the determination of the average level of fundamental and spurious emissions field strength, measurements were made of duty cycle to determine the transmission duration and the silent period time of the transmitter. The transmitter duty cycle was measured using a spectrum analyser in the time domain and calculated by using the following calculation:

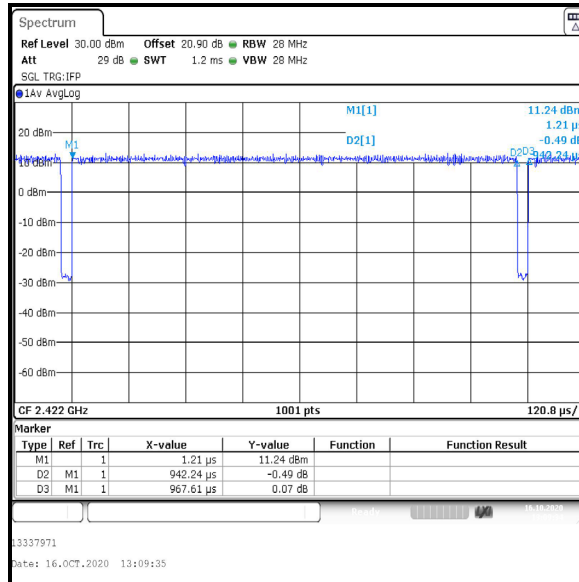
$$10 \log (1 / (\text{On Time} / [\text{Period or } 100 \text{ ms whichever is the lesser}])).$$

2. For all other modes, the duty cycle was measured and found to be greater than 98%. Plots for these measurements are archived on the UL International (UK) Ltd IT server and available for inspection upon request.

**Transmitter Duty Cycle (continued)**

**Results: 802.11n / 40 MHz / MCS0**

Pulse Duration (ms)	Period (ms)	Duty Cycle (dB)
0.942	0.968	0.1



## **4.2. Transmitter 99% Emission Bandwidth**

### **Test Summary:**

<b>Test Engineer:</b>	Max Passell	<b>Test Dates:</b>	11 June 2020 & 16 October 2020
<b>Test Sample Serial Numbers:</b>	3103753 & 3157589		

<b>FCC Reference:</b>	FCC Part 15.247 (a)(2)
<b>ISED Canada Reference:</b>	RSS-Gen 6.7
<b>Test Method Used:</b>	RSS-Gen 6.7 and Notes below

### **Environmental Conditions:**

<b>Temperature (°C):</b>	25 to 26
<b>Relative Humidity (%):</b>	33 to 46

### **Note(s):**

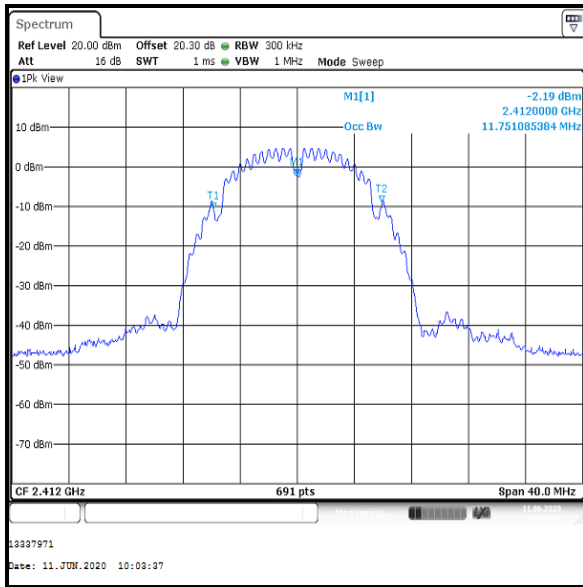
1. The 99% emission bandwidth was measured using the signal analyser occupied bandwidth function. The resolution bandwidth was set in the range of 1% to 5% of the occupied bandwidth and the video bandwidth set to 3 times the resolution bandwidth as the signal analyser allowed without being below 3 times RBW. The span was set to capture all products of the modulation process including emission skirts.
2. For 802.11b, 802.11g and 802.11n HT20, the signal analyser resolution bandwidth was set to 300 kHz and video bandwidth 1 MHz. A peak detector was used, sweep time was set to auto and the trace mode was Max Hold. The span was set to 40 MHz. The signal analyser function set the measurements to be made at 99% of the emission bandwidth. The results are given in the tables below.
3. For 802.11n HT40, the signal analyser resolution bandwidth was set to 1 MHz and video bandwidth 3 MHz. A peak detector was used, sweep time was set to auto and the trace mode was Max Hold. The span was set to 80 MHz. The signal analyser function set the measurements to be made at 99% of the emission bandwidth. The results are given in the tables below.
4. The signal analyser was connected to the RF port on the EUT using an RF switch, suitable attenuation and RF cables. An RF offset was entered on the signal analyser to compensate for the loss of the switch, attenuator and RF cables.



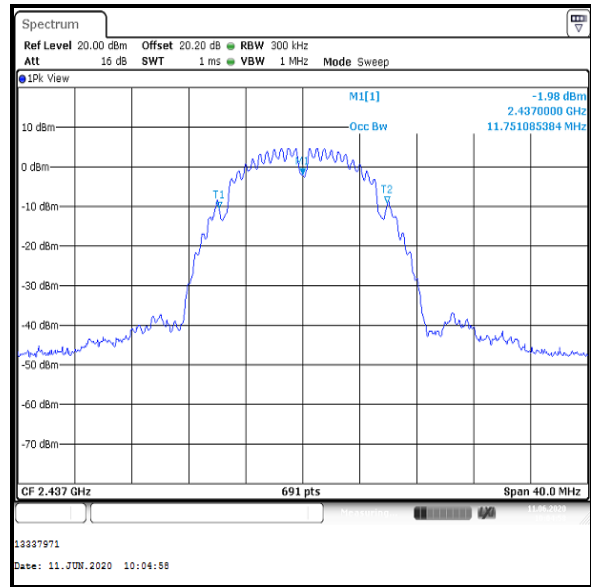
**Transmitter 99% Emission Bandwidth (continued)**

**Results: 802.11b / 20 MHz / DBPSK / 1 Mbps**

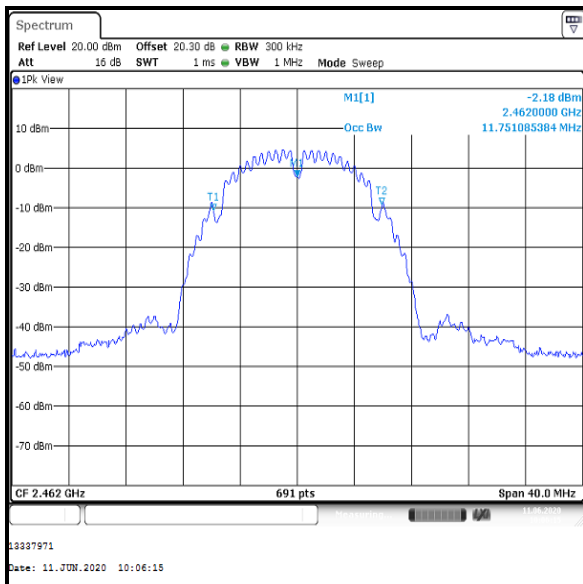
Channel	99% Emission Bandwidth (MHz)
Bottom	11.751
Middle	11.751
Top	11.751



**Bottom Channel**



**Middle Channel**

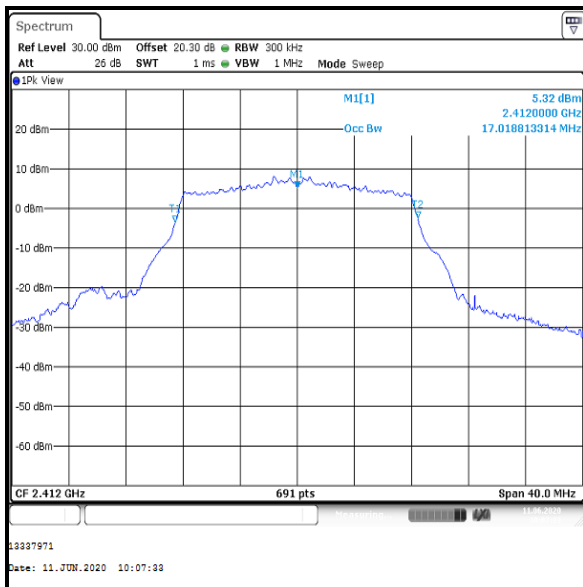


**Top Channel**

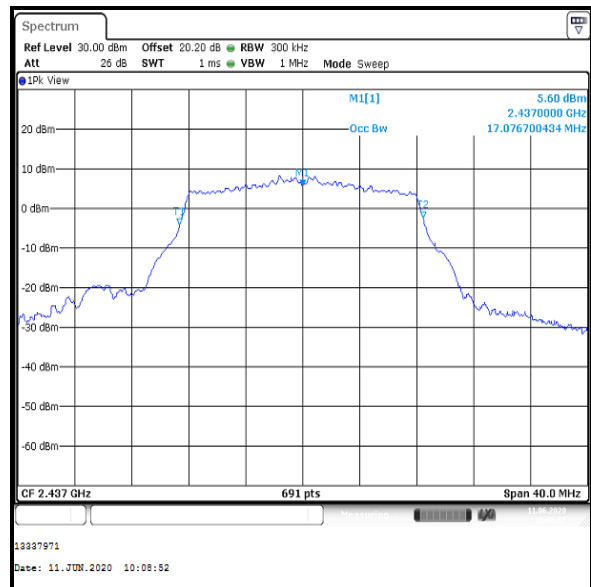
**Transmitter 99% Emission Bandwidth (continued)**

**Results: 802.11g / 20 MHz / BPSK / 6 Mbps**

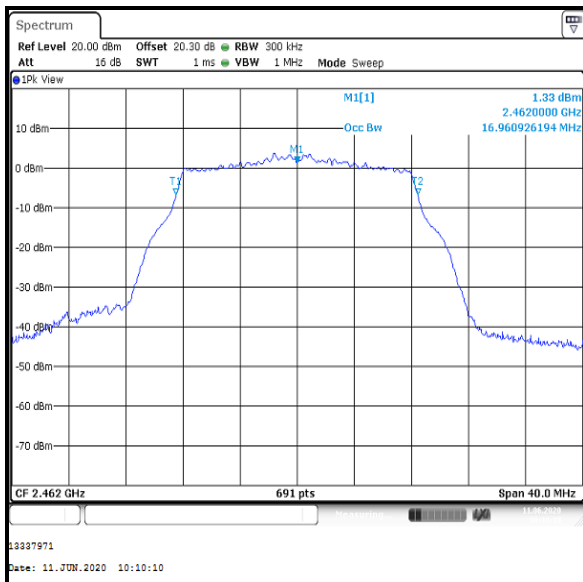
Channel	99% Emission Bandwidth (MHz)
Bottom	17.019
Middle	17.077
Top	16.961



**Bottom Channel**



**Middle Channel**

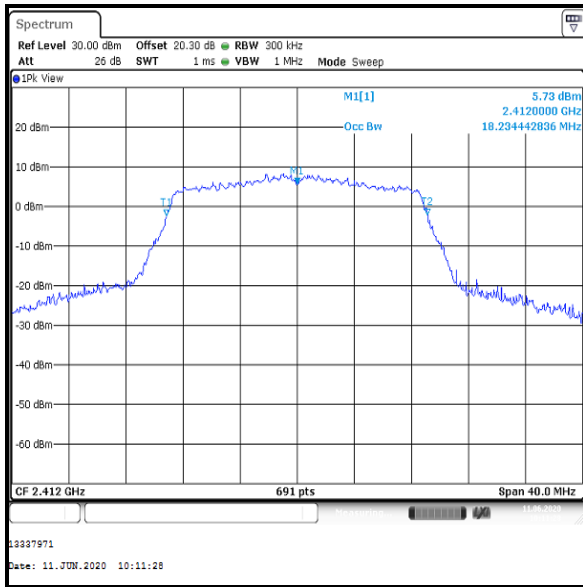


**Top Channel**

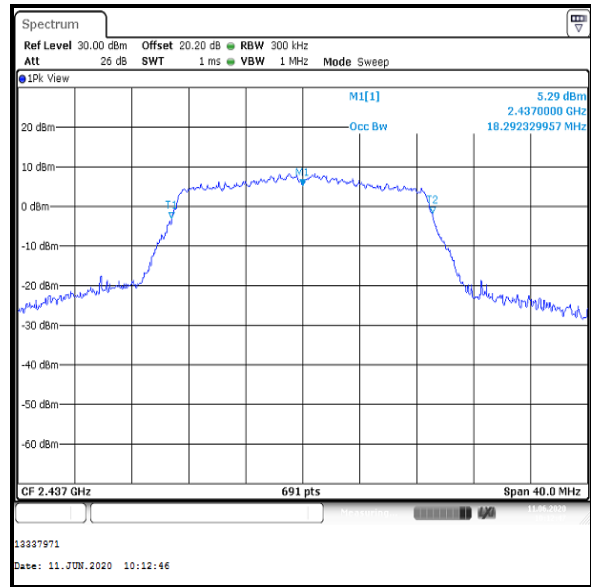
**Transmitter 99% Emission Bandwidth (continued)**

**Results: 802.11n / HT20 / BPSK / MCS0**

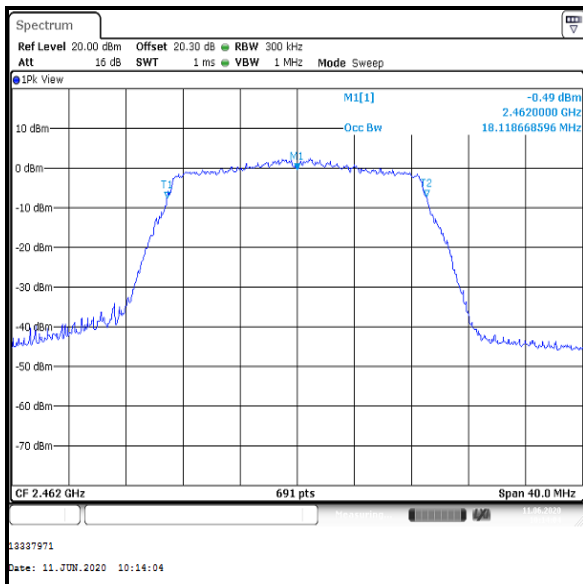
Channel	99% Emission Bandwidth (MHz)
Bottom	18.234
Middle	18.292
Top	18.119



Bottom Channel



Middle Channel

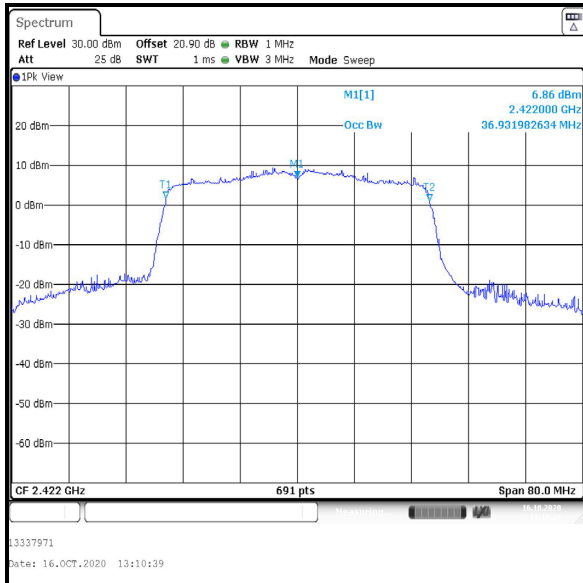


Top Channel

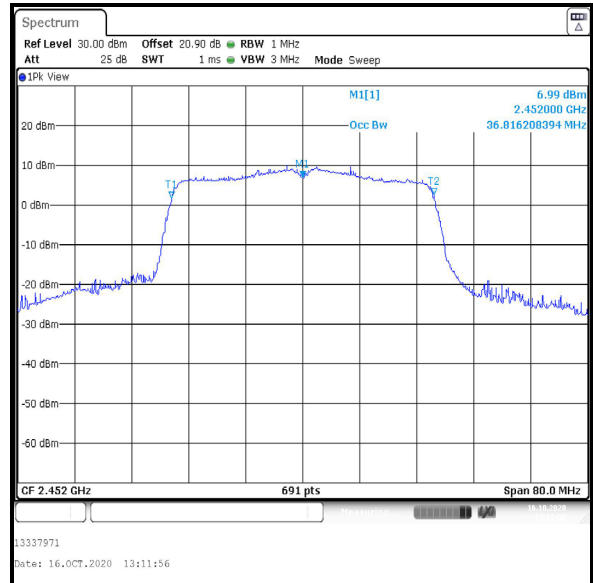
**Transmitter 99% Emission Bandwidth (continued)**

**Results: 802.11n / HT40 / MCS0**

Channel	99% Emission Bandwidth (MHz)
Bottom	36.932
Top	36.816



**Bottom Channel**



**Top Channel**

### **4.3. Transmitter Minimum 6 dB Bandwidth**

#### **Test Summary:**

<b>Test Engineer:</b>	Max Passell	<b>Test Dates:</b>	11 June 2020 & 16 October 2020
<b>Test Sample Serial Numbers:</b>	3103753 & 3157589		

<b>FCC Reference:</b>	Part 15.247(a)(2)
<b>ISED Canada Reference:</b>	RSS-Gen 6.7 / RSS-247 5.2(a)
<b>Test Method Used:</b>	FCC KDB 558074 Section 8.2 referencing ANSI C63.10 Section 11.8.1

#### **Environmental Conditions:**

<b>Temperature (°C):</b>	25 to 26
<b>Relative Humidity (%):</b>	33 to 48

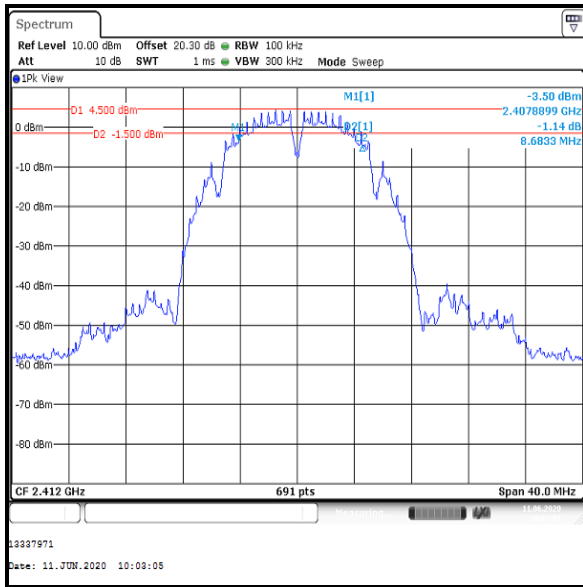
#### **Note(s):**

- Final measurements were performed on bottom, middle and top channels in accordance with ANSI C63.10 Section 11.8.1 Option 1 measurement procedure. The signal analyser resolution bandwidth was set to 100 kHz and video bandwidth 300 kHz. A peak detector was used, sweep time was set to auto and the trace mode was Max Hold. The span was set to 40 MHz for 20 MHz channel bandwidths and 80 MHz for 40 MHz channel bandwidths. The DTS bandwidth was measured at 6 dB down from the peak of the signal.
- The signal analyser was connected to the RF port on the EUT using an RF switch, suitable attenuation and RF cables. An RF offset was entered on the signal analyser to compensate for the loss of the switch, attenuator and RF cables.

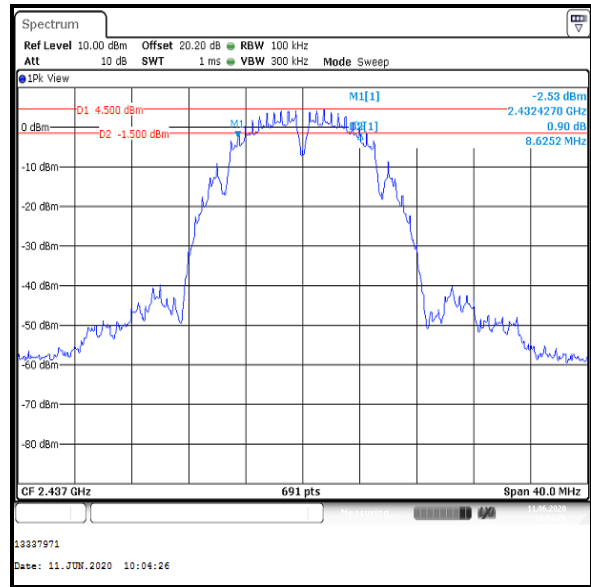
**Transmitter Minimum 6 dB Bandwidth (continued)**

**Results: 802.11b / 20 MHz / DBPSK / 1 Mbps**

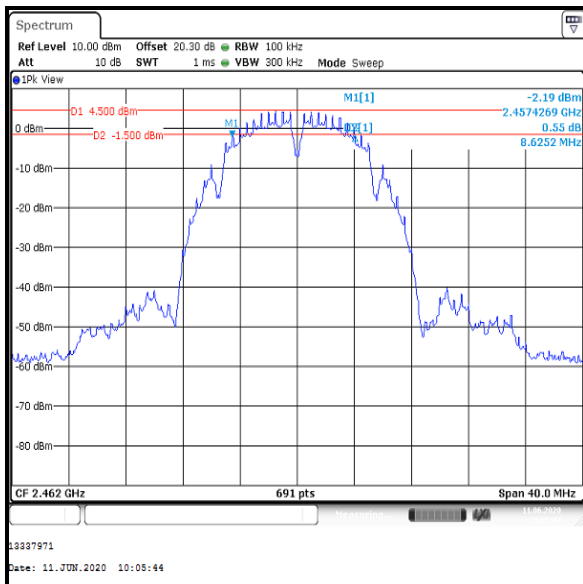
Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
Bottom	8683	≥500	8183	Complied
Middle	8625	≥500	8125	Complied
Top	8625	≥500	8125	Complied



**Bottom Channel**



**Middle Channel**

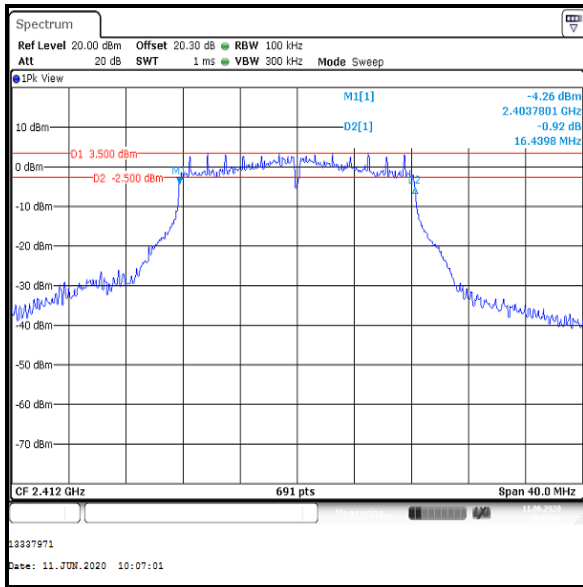


**Top Channel**

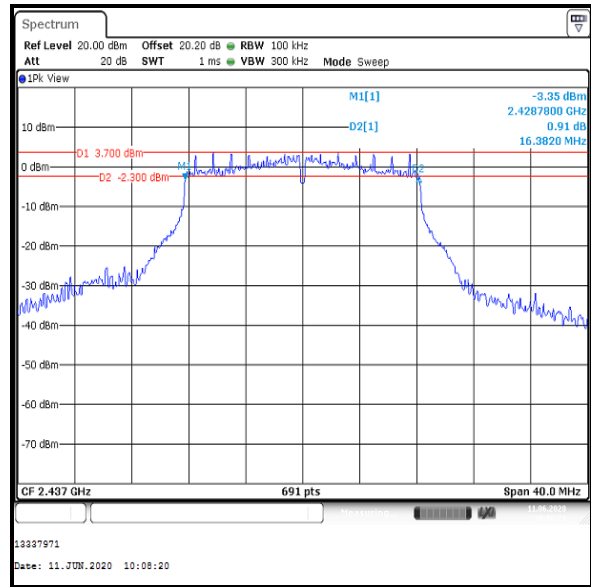
**Transmitter Minimum 6 dB Bandwidth (continued)**

**Results: 802.11g / 20 MHz / BPSK / 6 Mbps**

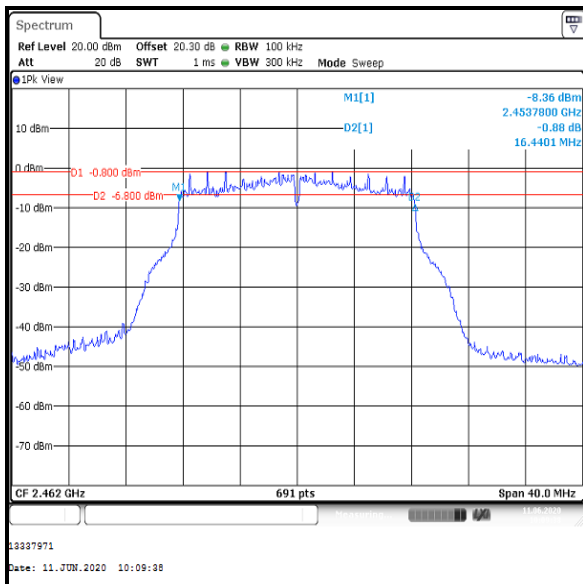
Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
Bottom	16440	≥500	15940	Complied
Middle	16382	≥500	15882	Complied
Top	16440	≥500	15940	Complied



Bottom Channel



Middle Channel

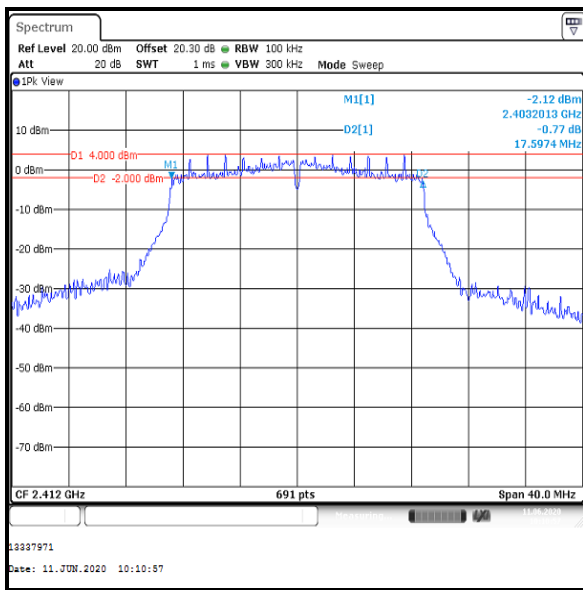


Top Channel

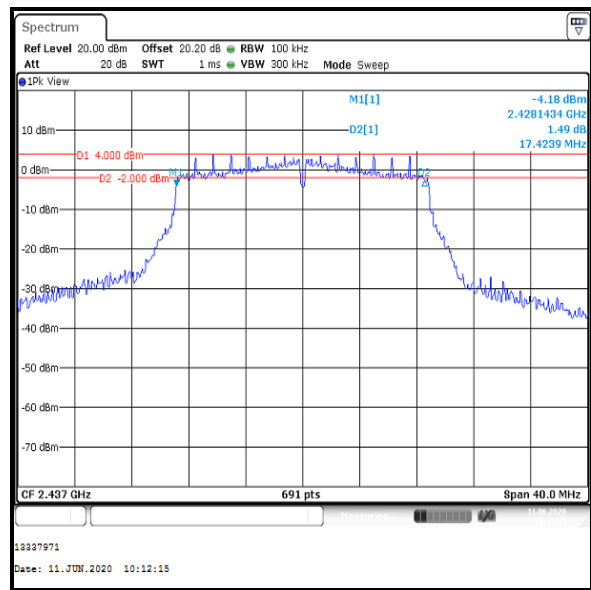
**Transmitter Minimum 6 dB Bandwidth (continued)**

**Results: 802.11n / HT20 / BPSK / MCS0**

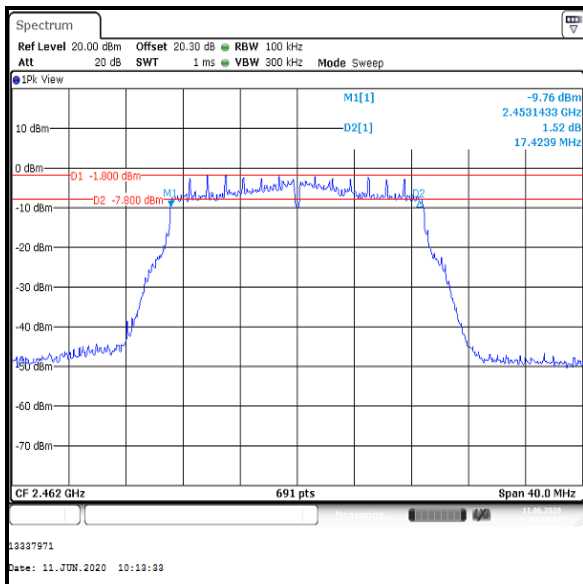
Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
Bottom	17597	≥500	17097	Complied
Middle	17424	≥500	16924	Complied
Top	17424	≥500	16924	Complied



Bottom Channel



Middle Channel



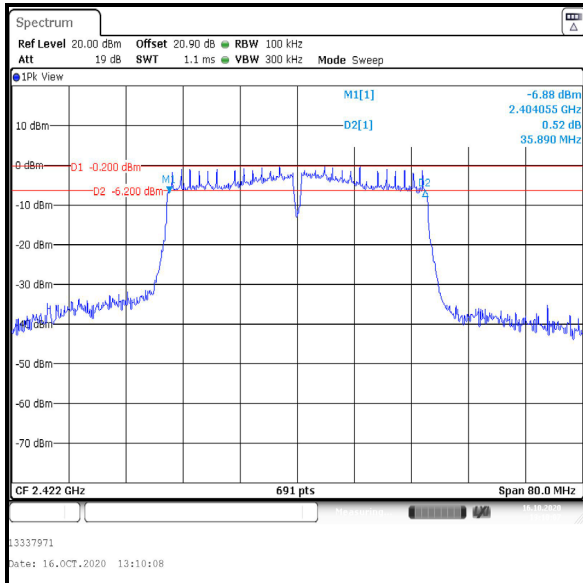
Top Channel



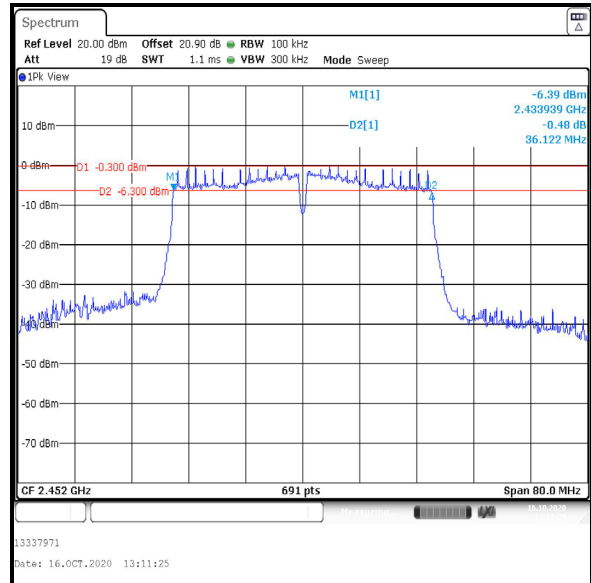
**Transmitter Minimum 6 dB Bandwidth (continued)**

**Results: 802.11n / HT40 / BPSK / MCS0**

Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
Bottom	35890	≥500	35390	Complied
Top	36122	≥500	35622	Complied



Bottom Channel



Top Channel

#### **4.4. Transmitter Power Spectral Density**

##### **Test Summary:**

<b>Test Engineer:</b>	Max Passell	<b>Test Dates:</b>	11 June 2020 & 16 October 2020
<b>Test Sample Serial Numbers:</b>	3103753 & 3157589		

<b>FCC Reference:</b>	Part 15.247(e)
<b>ISED Canada Reference:</b>	RSS-247 5.2(b)
<b>Test Method Used:</b>	FCC KDB 558074 Section 8.4 referencing ANSI C63.10 Sections 11.10.3 & 11.10.5

##### **Environmental Conditions:**

<b>Temperature (°C):</b>	25 to 26
<b>Relative Humidity (%):</b>	33 to 48

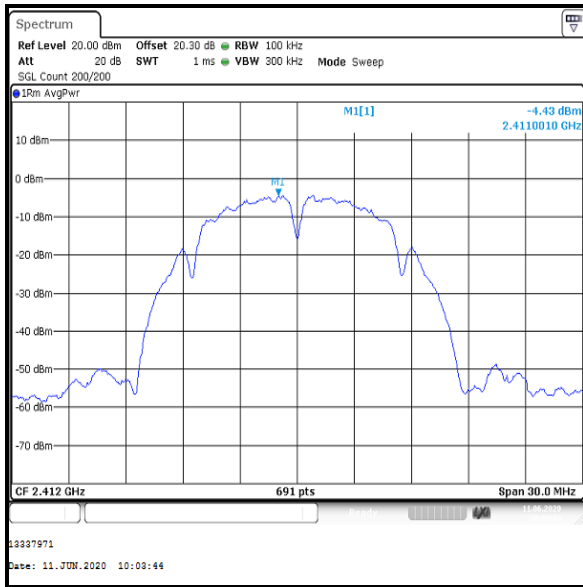
##### **Note(s):**

- Final measurements were performed on bottom, middle and top channels.
- For 802.11b, 802.11g and 802.11n HT20, the EUT was transmitting at  $\geq 98\%$  duty cycle and testing was performed in accordance with ANSI C63.10 Section 11.10.3 Method AVGPS-1. The signal analyser resolution bandwidth was set to 100 kHz and video bandwidth 300 kHz. An RMS detector was used and sweep time set manually to perform trace averaging over 200 traces. The span was set greater than 1.5 times the 99% emission bandwidth. The highest peak of the measured signal was recorded.
- For 802.11n HT40, the EUT was transmitting at  $<98\%$  duty cycle and testing was performed in accordance with ANSI C63.10 Section 11.10.5 Method AVGPS-2. The signal analyser resolution bandwidth was set to 100 kHz and video bandwidth 300 kHz. An RMS detector was used and sweep time set manually to perform trace averaging over 200 traces. The span was set greater than 1.5 times the 99% emission bandwidth. The highest peak of the measured signal was recorded. The calculated duty cycle in section 4.1 was added to the measured average power spectral density in order to compute the average power spectral density during the actual transmission time.
- The signal analyser was connected to the RF port on the EUT using an RF switch, suitable attenuation and RF cables. An RF offset was entered on the signal analyser to compensate for the loss of the switch, attenuator and RF cables.

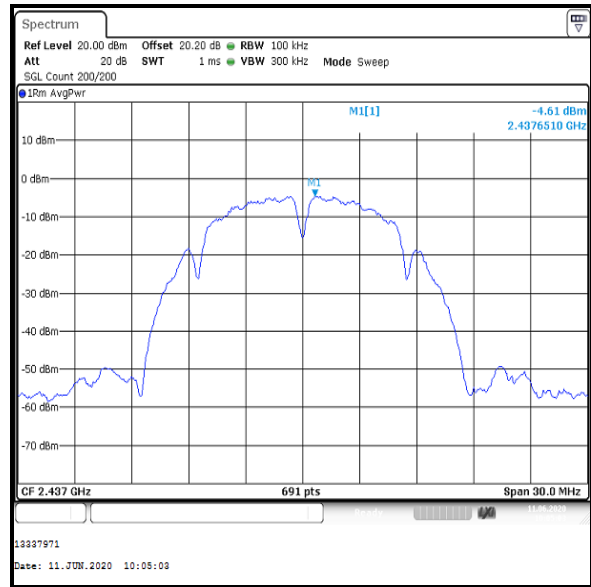
**Transmitter Power Spectral Density (continued)**

**Results: 802.11b / 20 MHz / DBPSK / 1 Mbps**

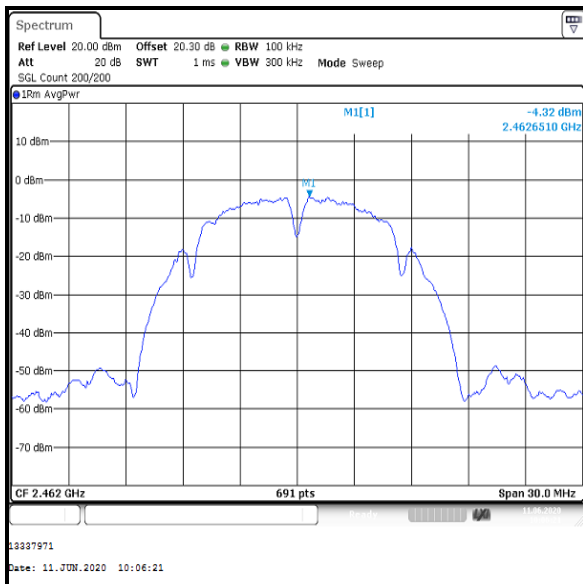
Channel	PSD (dBm /100 kHz)	Limit (dBm/3 kHz)	Margin (dB)	Result
Bottom	-4.4	8.0	12.4	Complied
Middle	-4.6	8.0	12.6	Complied
Top	-4.3	8.0	12.3	Complied



**Bottom Channel**



**Middle Channel**

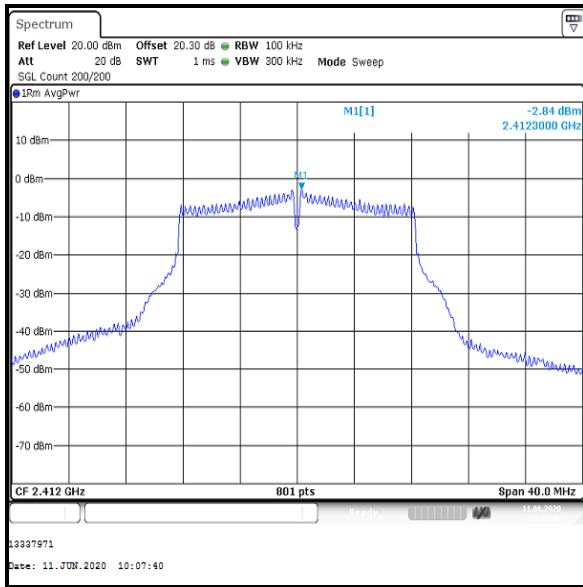


**Top Channel**

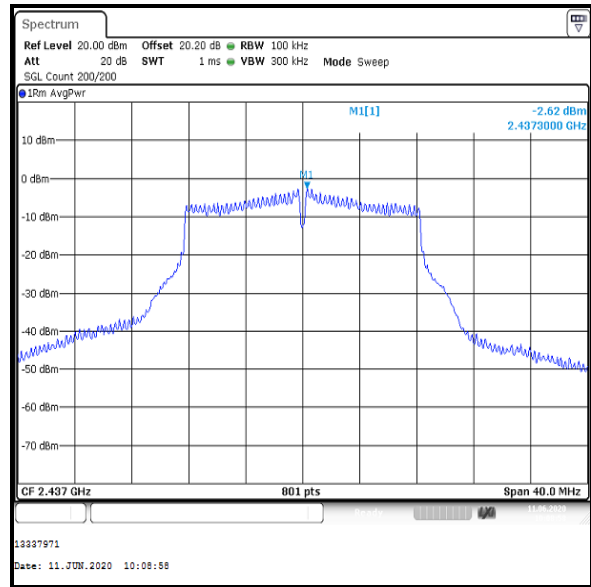
**Transmitter Power Spectral Density (continued)**

**Results: 802.11g / 20 MHz / BPSK / 6 Mbps**

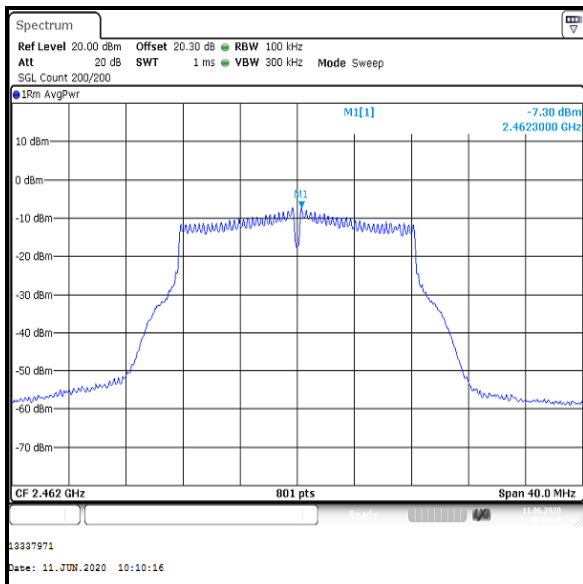
Channel	PSD (dBm/100 kHz)	Limit (dBm/3 kHz)	Margin (dB)	Result
Bottom	-2.8	8.0	10.8	Complied
Middle	-2.6	8.0	10.6	Complied
Top	-7.3	8.0	15.3	Complied



**Bottom Channel**



**Middle Channel**

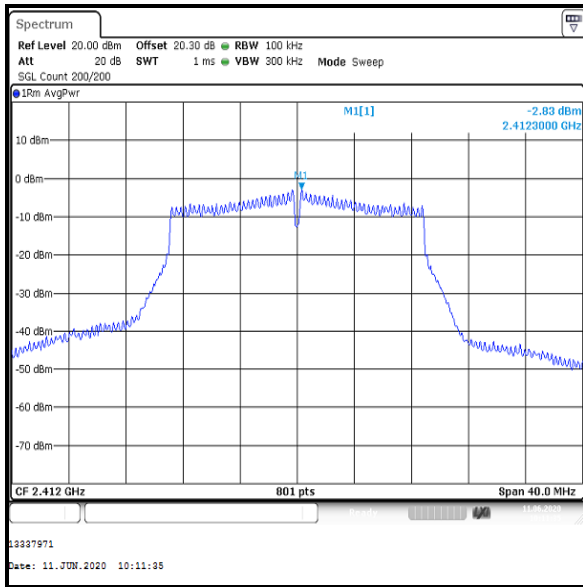


**Top Channel**

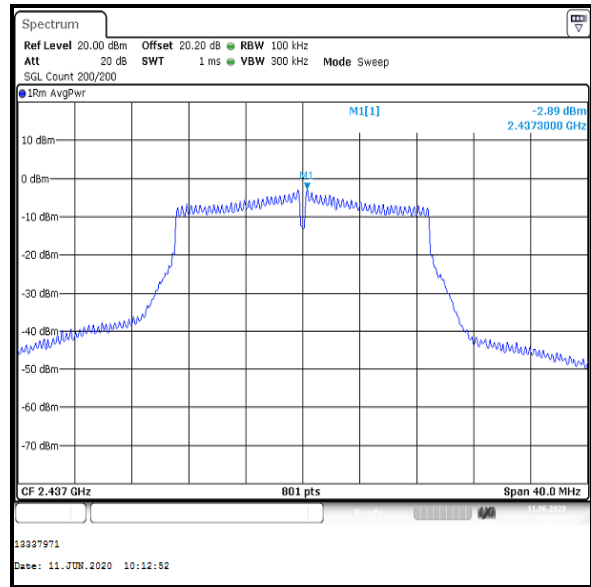
**Transmitter Power Spectral Density (continued)**

**Results: 802.11n / HT20 / BPSK / MCS0**

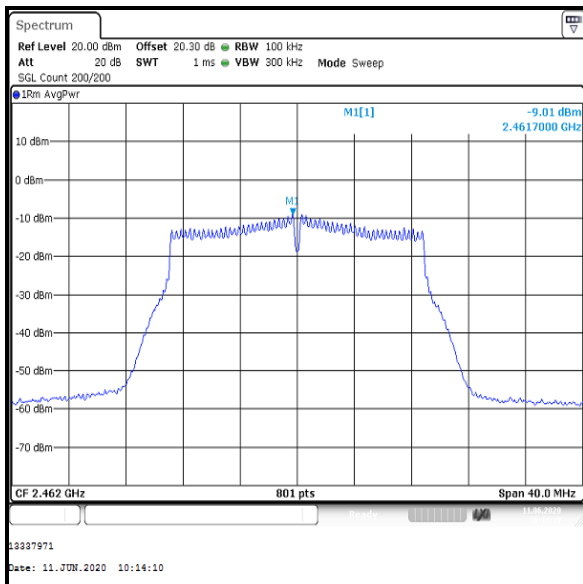
Channel	PSD (dBm/100 kHz)	Limit (dBm/3 kHz)	Margin (dB)	Result
Bottom	-2.8	8.0	10.8	Complied
Middle	-2.9	8.0	10.9	Complied
Top	-9.0	8.0	17.0	Complied



**Bottom Channel**



**Middle Channel**

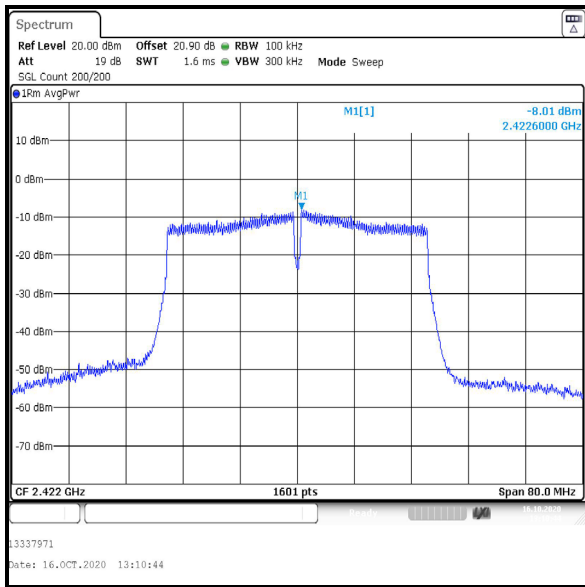


**Top Channel**

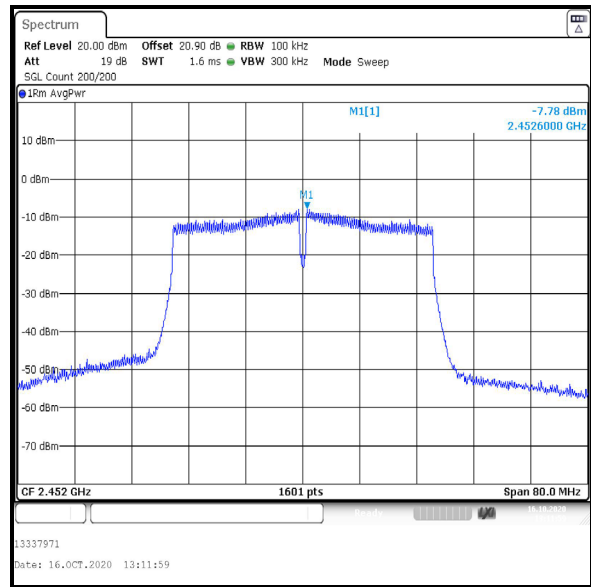
**Transmitter Power Spectral Density (continued)**

**Results: 802.11n / HT40 / BPSK / MCS0**

Channel	PSD (dBm/100 kHz)	Duty Cycle Correction (dB)	Corrected PSD (dBm/3 kHz)	Limit (dBm/3 kHz)	Margin (dB)	Result
Bottom	-8.0	0.1	-7.9	8.0	15.9	Complied
Top	-7.8	0.1	-7.7	8.0	15.7	Complied



**Bottom Channel**



**Top Channel**

#### **4.5. Transmitter Maximum (Average) Output Power**

##### **Test Summary:**

<b>Test Engineer:</b>	Max Passell	<b>Test Dates:</b>	11 June 2020 & 16 October 2020
<b>Test Sample Serial Numbers:</b>	3103753 & 3157589		

<b>FCC Reference:</b>	Part 15.247(b)(3)
<b>ISED Canada Reference:</b>	RSS-Gen 6.12 / RSS-247 5.4(d)
<b>Test Method Used:</b>	FCC KDB 558074 Section 8.3.2.2 referencing ANSI C63.10 Sections 11.9.2.2.2 & 11.9.2.2.4

##### **Environmental Conditions:**

<b>Temperature (°C):</b>	25 to 26
<b>Relative Humidity (%):</b>	33 to 46

##### **Note(s):**

- Final measurements were performed on bottom, middle and top channels. The power has been integrated over the 99% emission bandwidth.
- For 802.11b, the EUT was transmitting at  $\geq 98\%$  duty cycle and testing was performed in accordance with ANSI C63.10 Section 11.9.2.2.2 Method AVGSA-1. The signal analyser's integration function was used to integrate across the 99% occupied bandwidth. The signal analyser resolution bandwidth was set to 300 kHz and video bandwidth 1 MHz. An RMS detector was used and sweep time set manually to perform trace averaging over 200 traces. The span was set to at least 1.5 times the 99% occupied emission bandwidth.
- For 802.11g and 802.11n HT20, the EUT was transmitting at  $\geq 98\%$  duty cycle and testing was performed in accordance with ANSI C63.10 Section 11.9.2.2.2 Method AVGSA-1. The signal analyser's integration function was used to integrate across the 99% occupied bandwidth. The signal analyser resolution bandwidth was set to 500 kHz and video bandwidth 2 MHz. An RMS detector was used and sweep time set manually to perform trace averaging over 200 traces. The span was set to at least 1.5 times the 99% occupied emission bandwidth.
- For 802.11n HT40, the EUT was transmitting at  $<98\%$  duty cycle and testing was performed in accordance with ANSI C63.10 Section 11.9.2.2.4 Method AVGSA-2. The signal analyser's integration function was used to integrate across the 99% occupied bandwidth. The signal analyser resolution bandwidth was set to 1 MHz and video bandwidth 3 MHz. An RMS detector was used and sweep time set manually to perform trace averaging over 200 traces. The span was set to at least 1.5 times the 99% occupied emission bandwidth. The calculated duty cycle in section 4.1 was added to the measured power in order to compute the average power during the actual transmission time.
- The signal analyser was connected to the RF port on the EUT using an RF switch, suitable attenuation and RF cables. An RF offset was entered on the signal analyser to compensate for the loss of the switch, attenuator and RF cables.

**Transmitter Maximum (Average) Output Power (continued)****Results: 802.11b / 20 MHz / DBPSK / 1 Mbps****Conducted Peak Limit Comparison**

Channel	Conducted Power (dBm)	Conducted Power Limit (dBm)	Margin (dB)	Result
Bottom	12.7	30.0	17.3	Complied
Middle	12.7	30.0	17.3	Complied
Top	12.8	30.0	17.2	Complied

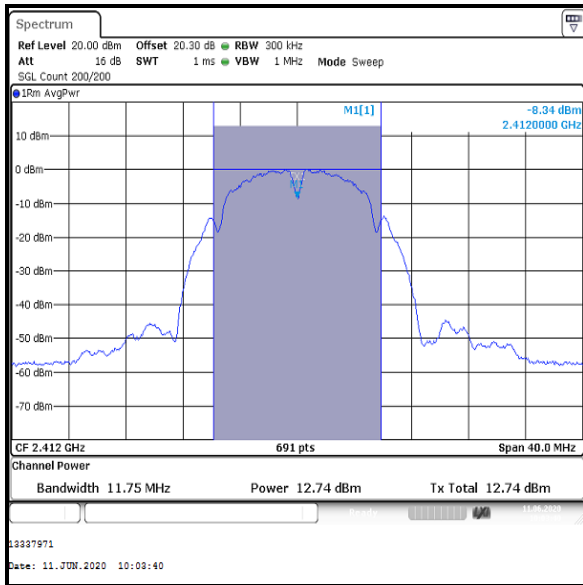
**EIRP Limit Comparison**

Channel	Conducted Power (dBm)	Highest Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
Bottom	12.7	3.5	16.2	36.0	19.8	Complied
Middle	12.7	3.5	16.2	36.0	19.8	Complied
Top	12.8	3.5	16.3	36.0	19.7	Complied

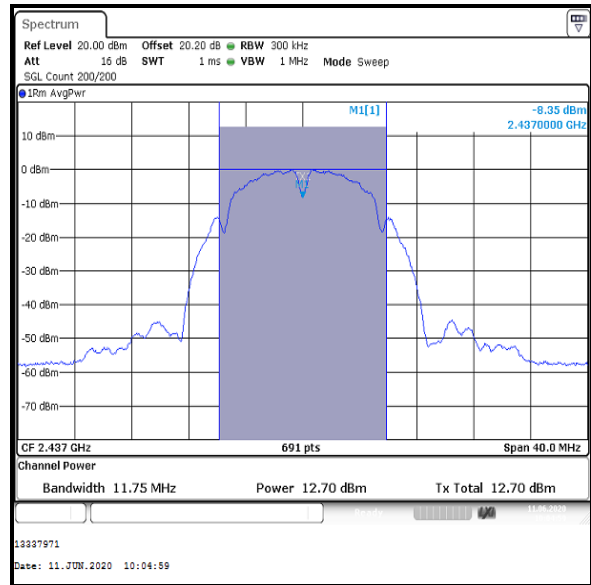


**Transmitter Maximum (Average) Output Power (continued)**

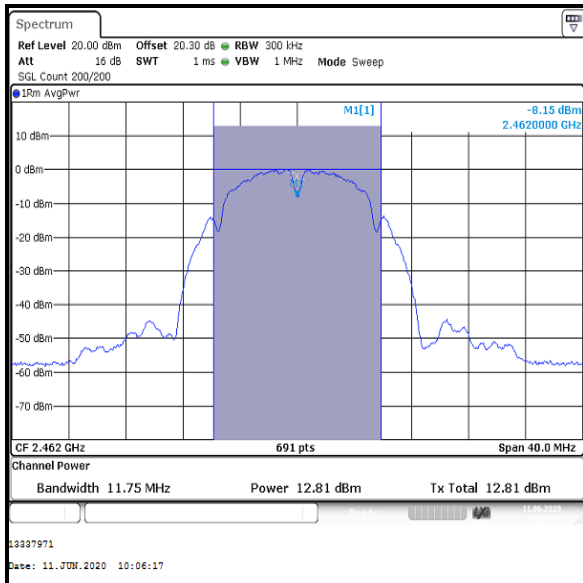
**Results: 802.11b / 20 MHz / DBPSK / 1 Mbps**



**Bottom Channel**



**Middle Channel**



**Top Channel**

**Transmitter Maximum (Average) Output Power (continued)****Results: 802.11g / 20 MHz / BPSK / 6 Mbps****Conducted Peak Limit Comparison**

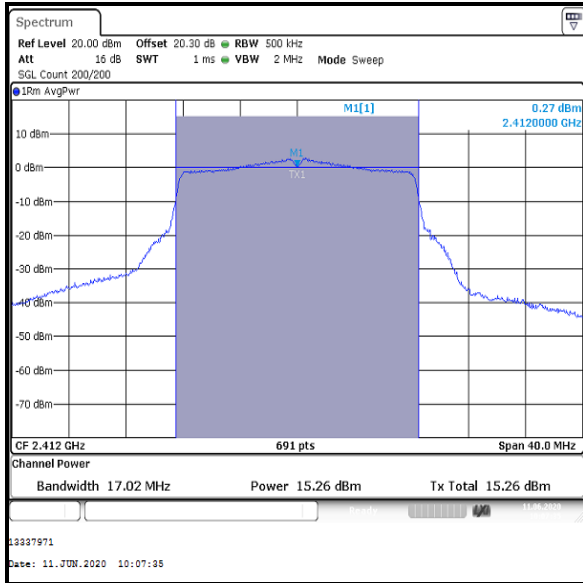
Channel	Conducted Power (dBm)	Conducted Power Limit (dBm)	Margin (dB)	Result
Bottom	15.3	30.0	14.7	Complied
Middle	15.4	30.0	14.6	Complied
Top	10.7	30.0	19.3	Complied

**EIRP Limit Comparison**

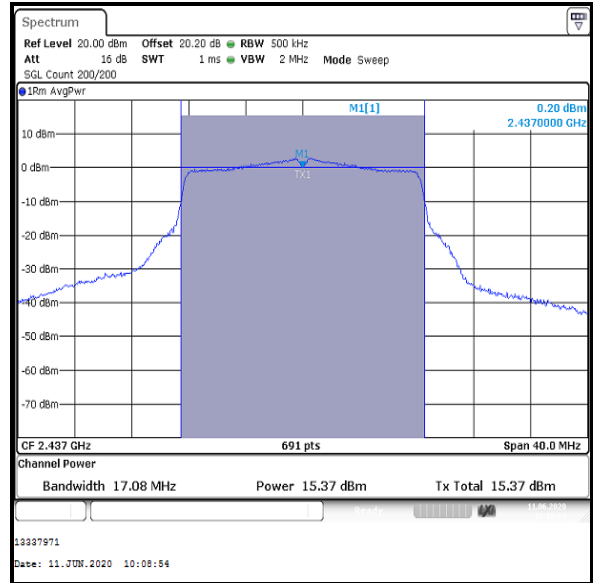
Channel	Conducted Power (dBm)	Highest Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
Bottom	15.3	3.5	18.8	36.0	17.2	Complied
Middle	15.4	3.5	18.9	36.0	17.1	Complied
Top	10.7	3.5	14.2	36.0	21.8	Complied

**Transmitter Maximum (Average) Output Power (continued)**

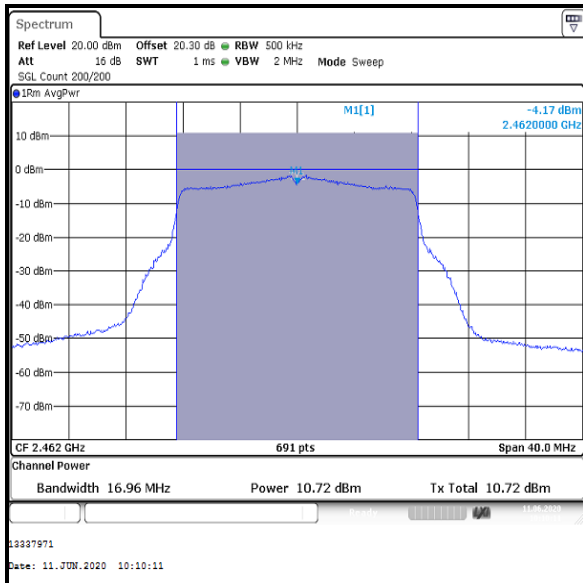
**Results: 802.11g / 20 MHz / BPSK / 6 Mbps**



**Bottom Channel**



**Middle Channel**



**Top Channel**

**Transmitter Maximum (Average) Output Power (continued)****Results: 802.11n / HT20 / BPSK / MCS0****Conducted Peak Limit Comparison**

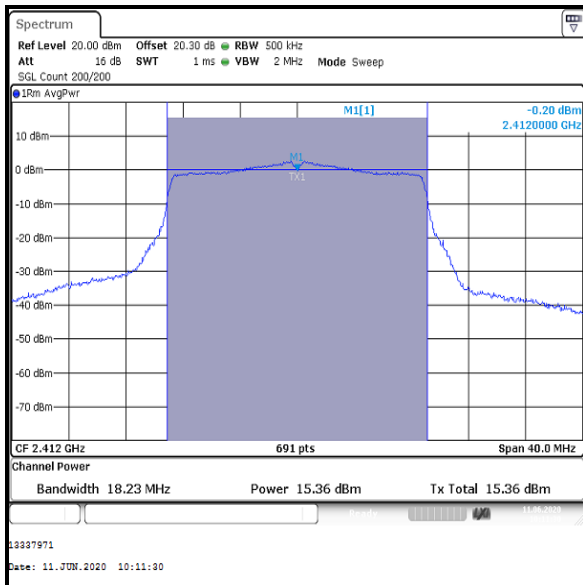
Channel	Conducted Power (dBm)	Conducted Power Limit (dBm)	Margin (dB)	Result
Bottom	15.4	30.0	14.6	Complied
Middle	15.3	30.0	14.7	Complied
Top	9.4	30.0	20.6	Complied

**EIRP Limit Comparison**

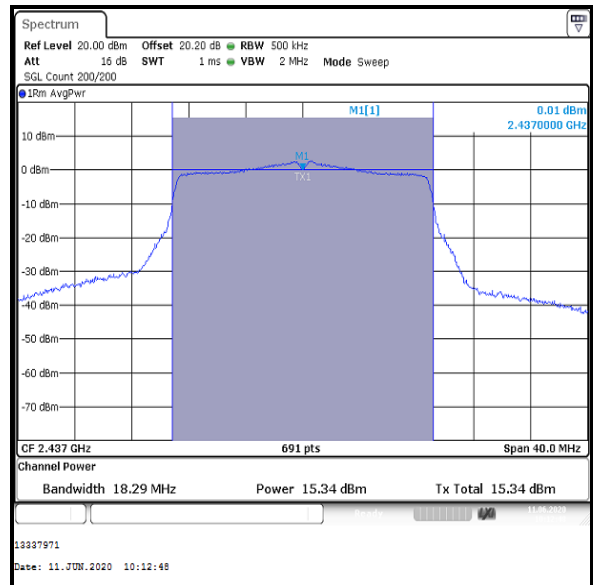
Channel	Conducted Power (dBm)	Highest Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
Bottom	15.4	3.5	18.9	36.0	17.1	Complied
Middle	15.3	3.5	18.8	36.0	17.2	Complied
Top	9.4	3.5	12.9	36.0	23.1	Complied

**Transmitter Maximum (Average) Output Power (continued)**

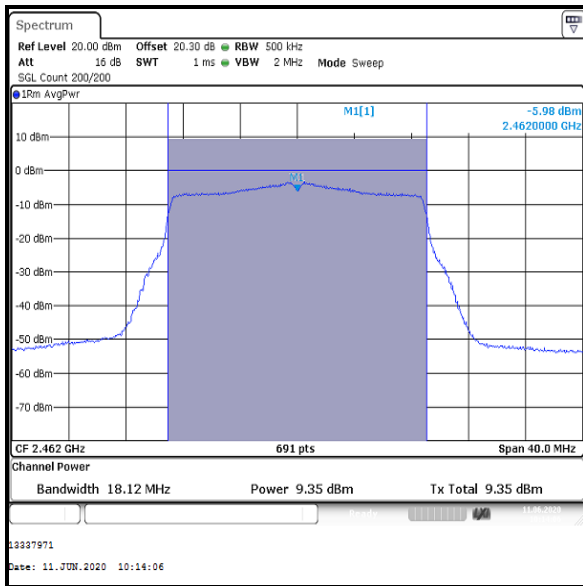
**Results: 802.11n / HT20 / BPSK / MCS0**



Bottom Channel



Middle Channel



Top Channel

**Transmitter Maximum (Average) Output Power (continued)**

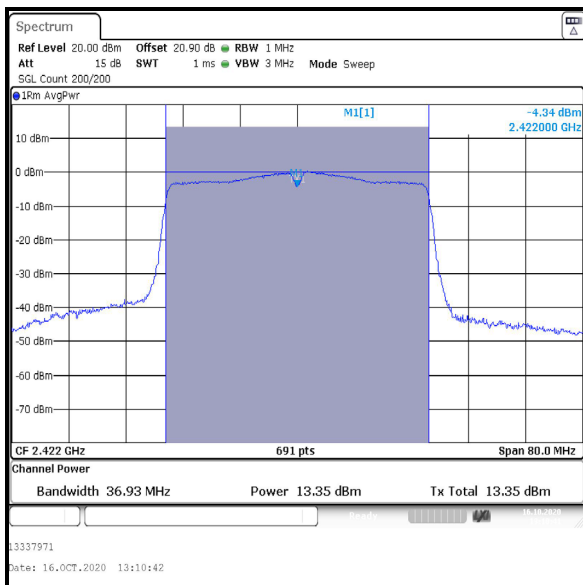
**Results: 802.11n / HT40 / BPSK / MCS0**

**Conducted Peak Limit Comparison**

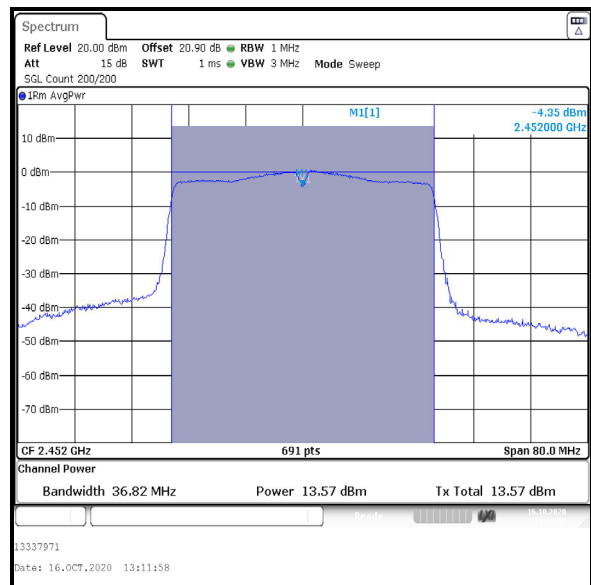
Channel	Conducted Power (dBm)	Duty Cycle Correction Factor (dB)	Corrected Conducted Power (dBm)	Conducted Power Limit (dBm)	Margin (dB)	Result
Bottom	13.4	0.1	13.5	30.0	16.5	Complied
Top	13.6	0.1	13.7	30.0	16.3	Complied

**EIRP Limit Comparison**

Channel	Corrected Conducted Power (dBm)	Highest Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
Bottom	13.5	3.5	17.0	36.0	19.0	Complied
Top	13.7	3.5	17.2	36.0	18.8	Complied



**Bottom Channel**



**Top Channel**

## **4.6. Transmitter Band Edge Conducted Emissions**

### **Test Summary:**

<b>Test Engineer:</b>	Matthew Botfield	<b>Test Date:</b>	28 October 2020
<b>Test Sample Serial Number:</b>	3185953		

<b>ISED Canada Reference:</b>	Parts 15.247(d) & 15.209(a)
<b>ISED Canada Reference:</b>	RSS-Gen 6.13 / RSS-247 5.5
<b>Test Method Used:</b>	KDB 558074 Section 8.7 referencing ANSI C63.10 Sections 6.10, 11.11, 11.12 & 11.13

### **Environmental Conditions:**

<b>Temperature (°C):</b>	21
<b>Relative Humidity (%):</b>	48

### **Note(s):**

1. The customer declared the following data rates to be used for all measurements as:
  - 802.11b – DBPSK / 1 Mbps
  - 802.11g – BPSK / 6 Mbps
  - 802.11n HT20 – BPSK / MCS0
  - 802.11n HT40 – BPSK / MCS0

Final measurements were performed with the above configurations.

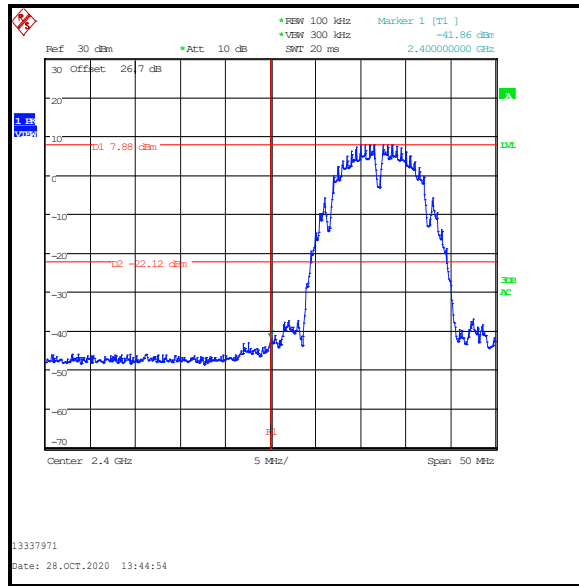
2. The maximum conducted (average) output power was previously measured. In accordance with FCC KDB 558074 Section 11.1(b), the lower band edge measurement should be performed with a peak detector and the -30 dBc limit applied.
3. As the band edge are adjacent to non-restricted bands, only peak measurements are required. In accordance with FCC KDB 558074 Section 11.1, the test method in Section 11.3 was followed: the test receiver resolution bandwidth was set to 100 kHz and video bandwidth 300 kHz. A peak detector was used, sweep time was set to auto and trace mode was Max Hold. The test receiver was left to sweep for a sufficient length of time in order to maximise the carrier level and out-of-band emissions. A marker and corresponding reference level line were placed on the peak of the carrier. As the maximum conducted (average) output power was measured using an RMS detector in accordance with FCC KDB 558074 Section 9.2.2.4 an out-of-band limit line was placed 30 dB (FCC KDB 558074 Section 11.1(b)) below the peak level. A marker was placed on the band edge spot frequencies and a second marker placed on the highest emission level in the adjacent non-restricted band of operation (where a higher level emission was present). Marker frequencies and levels were recorded.
4. Upper band edge and restricted band results are contained within test report R13337971-E1 / E2.

**Transmitter Band Edge Radiated Emissions (continued)**

**Results: 802.11b / 20 MHz / DBPSK / 1 Mbps**

**Results: Lower Band Edge**

Frequency (MHz)	Level (dBm)	-30 dBc Limit (dBm)	Margin (dB)	Result
2400	-41.9	-22.1	19.8	Complied



**Lower Band Edge**

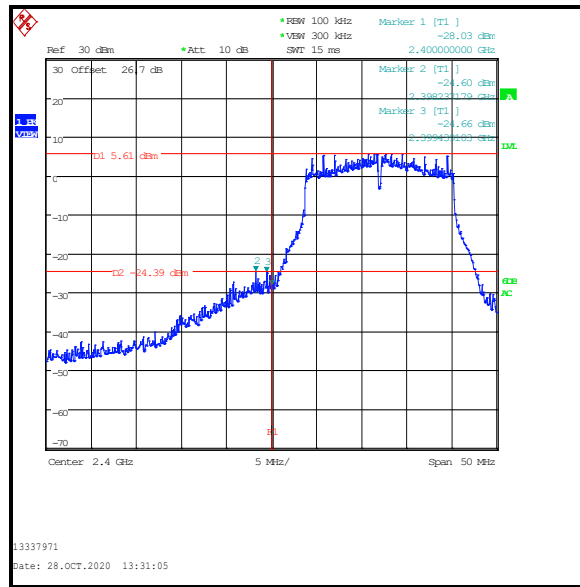


**Transmitter Band Edge Radiated Emissions (continued)**

**Results: 802.11g / 20 MHz / BPSK / 6 Mbps**

**Results: Lower Band Edge**

Frequency (MHz)	Level (dBm)	-30 dBc Limit (dBm)	Margin (dB)	Result
2398.237	-24.6	-24.4	0.2	Complied
2399.439	-24.7	-24.4	0.3	Complied
2400.000	-28.0	-24.4	3.6	Complied



**Lower Band Edge**

**Transmitter Band Edge Radiated Emissions (continued)**

**Results: 802.11n HT20 / BPSK / MCS0**

**Results: Lower Band Edge**

Frequency (MHz)	Level (dBm)	-30 dBc Limit (dBm)	Margin (dB)	Result
2398.558	-25.4	-24.1	1.3	Complied
2400.000	-27.2	-24.1	3.1	Complied



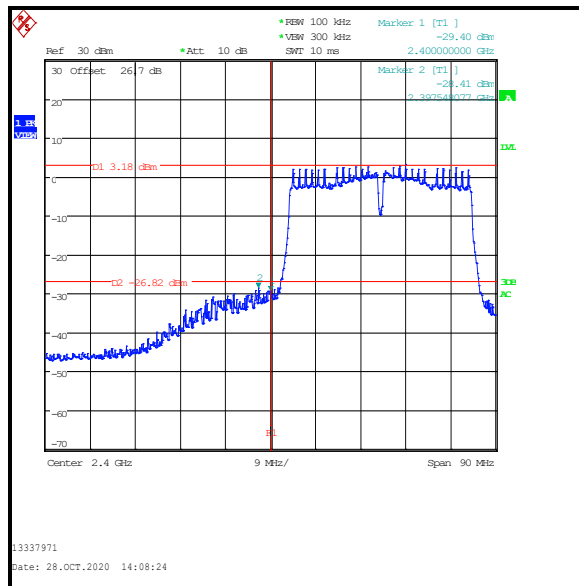
**Lower Band Edge**

**Transmitter Band Edge Radiated Emissions (continued)**

**Results: 802.11n HT40 / BPSK / MCS0**

**Results: Lower Band Edge**

Frequency (MHz)	Level (dBm)	-30 dBc Limit (dBm)	Margin (dB)	Result
2397.548	-28.4	-26.8	1.6	Complied
2400.000	-29.4	-26.8	2.6	Complied



**Lower Band Edge**

**--- END OF REPORT ---**