

TEST REPORT

Test Report No. : UL-RPT-RP14652416-216A

Customer : Buddi Limited

Model No. / HVIN : 3430016

PMN : Smart Tag 5

FCC ID : ZDLST7

ISED Certification No. : 20371-ST7

Technology : 2.4 GHz WLAN

Test Standard(s) : FCC Parts 15.209 & 15.247
Innovation, Science and Economic Development Canada
RSS-247 Issue 2
RSS-Gen Issue 5

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: 18 May 2023

Checked by:



Ben Mercer
Lead Project Engineer, Radio Laboratory

Company Signatory:



Sarah Williams
RF Operations Leader, Radio Laboratory



5772

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Customer Information

Company Name:	Buddi Limited
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Report Revision History

Version Number	Issue Date	Revision Details	Revised By
1.0	05/04/2023	Initial Version	Ben Mercer
2.0	12/05/2023	Conducted results added	Ben Mercer
3.0	18/05/2023	99% Occupied Bandwidth references updated	Ben Mercer
4.0	18/05/2023	6 dB Bandwidth references updated	Ben Mercer

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1 Attestation of Test Results









1.1 Description of EUT

The equipment under test was an Electronic Monitoring (EM) device which communicates to a server-based monitoring platform providing data such as: event time, GPS location, geo-fence data, position type, speed of motion, battery level, signal strength, strap on/off, alerts. It contains a 2G and 4G cellular module (FCC ID:XPYUBX21BE01, IC: 8595AUBX21BE01), a 2.4 GHz WLAN transceiver and a 915 MHz ISM transceiver.

1.2 General Information

Specification Reference:	47CFR15.247
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) - Section 15.247
Specification Reference:	47CFR15.209
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) - Section 15.209
Specification Reference:	RSS-247 Issue 2 February 2017
Specification Title:	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices
Specification Reference:	RSS-Gen Issue 5 February 2021
Specification Title:	General Requirements for Compliance of Radio Apparatus
FCC Site Registration:	685609
ISED Site Registration:	20903
FCC Lab. Designation No.:	UK2011
ISED CABID:	UK0001
Location of Testing:	Unit 3 Horizon, Wade Road, Kingsland Business Park, Basingstoke, Hampshire, RG24 8AH, United Kingdom
Test Dates:	28 February 2023 to 28 April 2023

1.3 Summary of Test Results

FCC Reference (47CFR)	ISED Canada Reference	Measurement	Result
Part 15.35(c)	RSS-Gen 6.10	Transmitter Duty Cycle	Note 1
N/A	RSS-Gen 6.6	Transmitter 99% Emission Bandwidth	
Part 15.247(a)(2)	RSS-Gen 6.6 / 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 Output Power	
Part 15.247(d) & 15.209(a)	RSS-Gen 6.13 / RSS-247 5.5	Transmitter Radiated Emissions	
Part 15.247(d) & 15.209(a)	RSS-Gen 6.13 / RSS-247 5.5	Transmitter Band Edge Radiated Emissions	
Key to Results			
 = Complied  = Did not comply			

Note(s):

- The measurement was performed to assist in the calculation of the level of maximum radiated emissions. The EUT cannot transmit continuously and sweep triggering/signal gating cannot be implemented.

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. The following table identifies which facilities were utilised for radiated emission measurements documented in this report. Specific facilities are also identified in the test results sections.

Site 1	X
Site 2	-
Site 17	X

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

Reference:	ANSI C63.10-2013
Title:	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
Reference:	KDB 558074 D01 15.247 Meas Guidance v05r01 February 11, 2019
Title:	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”.

Measurement Type	Range	Confidence Level (%)	Calculated Uncertainty
Duty Cycle	2.4 GHz to 2.4835 GHz	95%	±1.14 %
99% Emission Bandwidth	2.4 GHz to 2.4835 GHz	95%	±3.92 %
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
Radiated Spurious Emissions	9 kHz to 30 MHz	95%	±5.32 dB
Radiated Spurious Emissions	30 MHz to 1 GHz	95%	±3.30 dB
Radiated Spurious Emissions	1 GHz to 25 GHz	95%	±3.16 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 99% Emission Bandwidth, Minimum 6 dB Bandwidth, Power Spectral Density & Maximum Output Power

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2071	Thermohygrometer	Testo	608-H1	45258132	08 Dec 2023	12
M2033	Signal Analyser	Rohde & Schwarz	FSV13	101667	11 Aug 2023	12
G0642	Signal Generator	Rohde & Schwarz	SMBV100B	100890	23 Aug 2025	12
A3119	Attenuator	AtlanTecRF	AN18-10	237378#3	Calibrated before use	-

Test Equipment Used for Transmitter Duty Cycle

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2040	Thermohygrometer	Testo	608-H1	45124934	09 Dec 2023	12
K0001	3m RSE Chamber	Rainford EMC	N/A	N/A	05 Sep 2023	12
M1874	Test Receiver	Rohde & Schwarz	ESU26	100553	19 May 2023	12
A222867	Pre-Amplifier	Atlantic Microwave	A-LNAKX-380116-S5S5	220705002	26 Aug 2023	12
A2523	Attenuator	AtlanTecRF	AN18W5-10	832827#1	26 Jan 2024	12
A3138	Antenna	Schwarzbeck	BBHA 9120 B	00702	22 Aug 2023	12

Test and Measurement Equipment (continued)**Test Equipment Used for Transmitter Radiated Emissions Tests**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2040	Thermohygrometer	Testo	608-H1	45124934	09 Dec 2023	12
K0001	3m RSE Chamber	Rainford EMC	N/A	N/A	05 Sep 2023	12
M1874	Test Receiver	Rohde & Schwarz	ESU26	100553	19 May 2023	12
A222867	Pre-Amplifier	Atlantic Microwave	A-LNAKX-380116-S5S5	220705002	26 Aug 2023	12
A3265	Pre-Amplifier	Schwarzbeck	BBV 9721	9721-069	31 Oct 2023	12
A3138	Antenna	Schwarzbeck	BBHA 9120 B	00702	22 Aug 2023	12
A3139	Antenna	Schwarzbeck	HWRD750	00027	22 Aug 2023	12
A2892	Antenna	Schwarzbeck	BBHA 9170	9170-727	31 Oct 2023	12
A3165	Antenna	ETS-Lindgren	6502	00224383	05 May 2023	12
A2523	Attenuator	AtlanTecRF	AN18W5-10	832827#1	26 Jan 2024	12
A3093	High Pass Filter	AtlanTecRF	AFH-03000	18051800077	26 Jan 2024	12
A3095	High Pass Filter	AtlanTecRF	AFH-07000	18051600012	27 Jan 2024	12
M2003	Thermohygrometer	Testo	608-H1	45046641	09 Dec 2023	12
K0017	3m RSE Chamber	Rainford EMC	N/A	N/A	08 Nov 2023	12
M1995	Test Receiver	Rohde & Schwarz	ESU26	100428	02 Nov 2023	12
A490	Antenna	Chase EMC Ltd	CBL6111A	1590	06 Nov 2023	12
A3036	Low Pass Filter	AtlanTecRF	AFL-02000	15062902848	25 Jan 2024	12
A3167	Pre Amplifier	Com Power	PAM-103	18020010	02 Nov 2023	12
A2889	Antenna	Schwarzbeck	BBHA 9120 B	00653	02 Nov 2023	12
A2914	Attenuator	AtlanTecRF	AFH-03000	2155	25 Jan 2024	12

Test Equipment Used for Transmitter Band Edge Radiated Emissions

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2040	Thermohygrometer	Testo	608-H1	45124934	09 Dec 2023	12
K0001	3m RSE Chamber	Rainford EMC	N/A	N/A	05 Sep 2023	12
M1874	Test Receiver	Rohde & Schwarz	ESU26	100553	19 May 2023	12
A222867	Pre-Amplifier	Atlantic Microwave	A-LNAKX-380116-S5S5	220705002	26 Aug 2023	12
A2523	Attenuator	AtlanTecRF	AN18W5-10	832827#1	26 Jan 2024	12
A3138	Antenna	Schwarzbeck	BBHA 9120 B	00702	22 Aug 2023	12

3 Equipment Under Test (EUT)

3.1 Identification of Equipment Under Test (EUT)

Brand Name:	Buddi
Model Number / HVIN:	3430016
PMN:	Smart Tag 5
Test Sample Serial Number:	SXW00036 (<i>Radiated sample #1</i>)
Hardware Version:	V15.1
Firmware Version:	1.40.20
FCC ID:	ZDLST7
ISED Canada Certification Number:	20371-ST7
Date Sample Received:	27 February 2023

Brand Name:	Buddi
Model Number / HVIN:	3430016
PMN:	Smart Tag 5
Test Sample Serial Number:	SXW00037 (<i>Radiated sample #2</i>)
Hardware Version:	V15.1
Software Version:	1.40.20
FCC ID:	ZDLST7
ISED Canada Certification Number:	20371-ST7
Date Sample Received:	27 February 2023

Brand Name:	Buddi
Model Number / HVIN:	3430016
PMN:	Smart Tag 5
Test Sample Serial Number:	SXW00047 (<i>Conducted sample #1</i>)
Hardware Version:	V15.1
Software Version:	1.40.20
FCC ID:	ZDLST7
ISED Canada Certification Number:	20371-ST7
Date Sample Received:	25 April 2023

3.2 Modifications Incorporated in the EUT

No modifications were applied to the EUT during testing.

3.3 Additional Information Related to Testing

Technology Tested:	WLAN (IEEE 802.11b,g,n) / Digital Transmission System		
Type of Unit:	Transceiver		
Modulation Type:	DBPSK, BPSK		
Data Rates:	802.11b	1 Mbps	
	802.11g	6 Mbps	
	802.11n HT20	MCS0	
Power Supply Requirement(s):	Nominal	3.7 VDC	
Maximum Conducted Output Power:	15.7 dBm		
Channel Spacing:	20 MHz		
Transmit Frequency Range:	2412 MHz to 2472 MHz		
Transmit Channels Tested:	Channel ID	Channel Number	Channel Frequency (MHz)
	Bottom	1	2412
	Middle	6	2437
	Top	11	2462

3.4 Description of Available Antenna

The radio utilizes an integrated antenna, with the following maximum gain:

Frequency Range (MHz)	Antenna Gain (dBi)
2400 to 2483.5	-1.5

3.5 Description of Test Setup

Support Equipment

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

Brand Name:	Buddi
Description:	On Body Charger (Battery pack)
Model Name or Number:	OBC V3/3610000
Serial Number:	Not marked or stated

Brand Name:	Buddi
Description:	Switching Power Adapter
Model Name or Number:	Not marked or stated
Serial Number:	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 bottom, middle and top channels as required using the supported data rates/modulation types.

Configuration and Peripherals

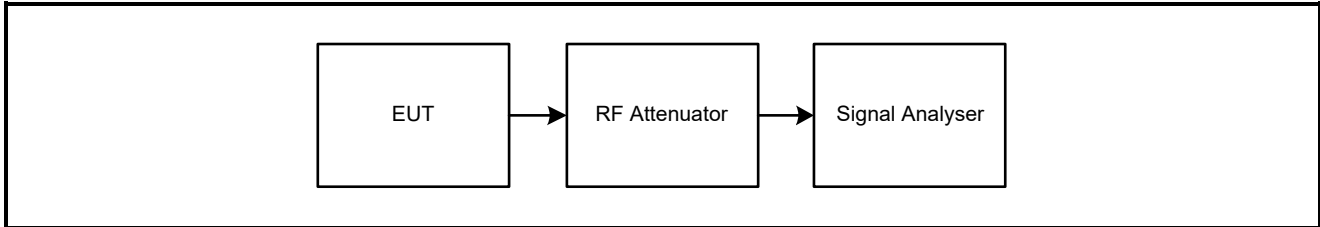
The EUT was tested in the following configuration(s):

- The customer had pre-loaded test software/firmware to the EUT prior to testing. Test mode was enabled following the instructions in 'Smart Tag 5XB - WIFI FCC Test Guide v1.0.pdf', Issue Date: 23rd February 2023. A modified Switching Power Adaptor was provided by the customer for test mode purposes only. This allowed selection of test mode parameters via a button in accordance with the provided instructions.
- The customer declared the following worst-case data rates to be used for all measurements:
 - 802.11b – 1 Mbps
 - 802.11g – 6 Mbps
 - 802.11n – MCS0
- Transmitter spurious emissions were performed with the EUT transmitting with a data rate of 802.11g 6 Mbps. This was deemed to be the worst case as this mode emits the highest output power level.
- All radiated tests were performed with the EUT placed in the worst case orientation/position for the applicable test.

Test Setup Diagrams

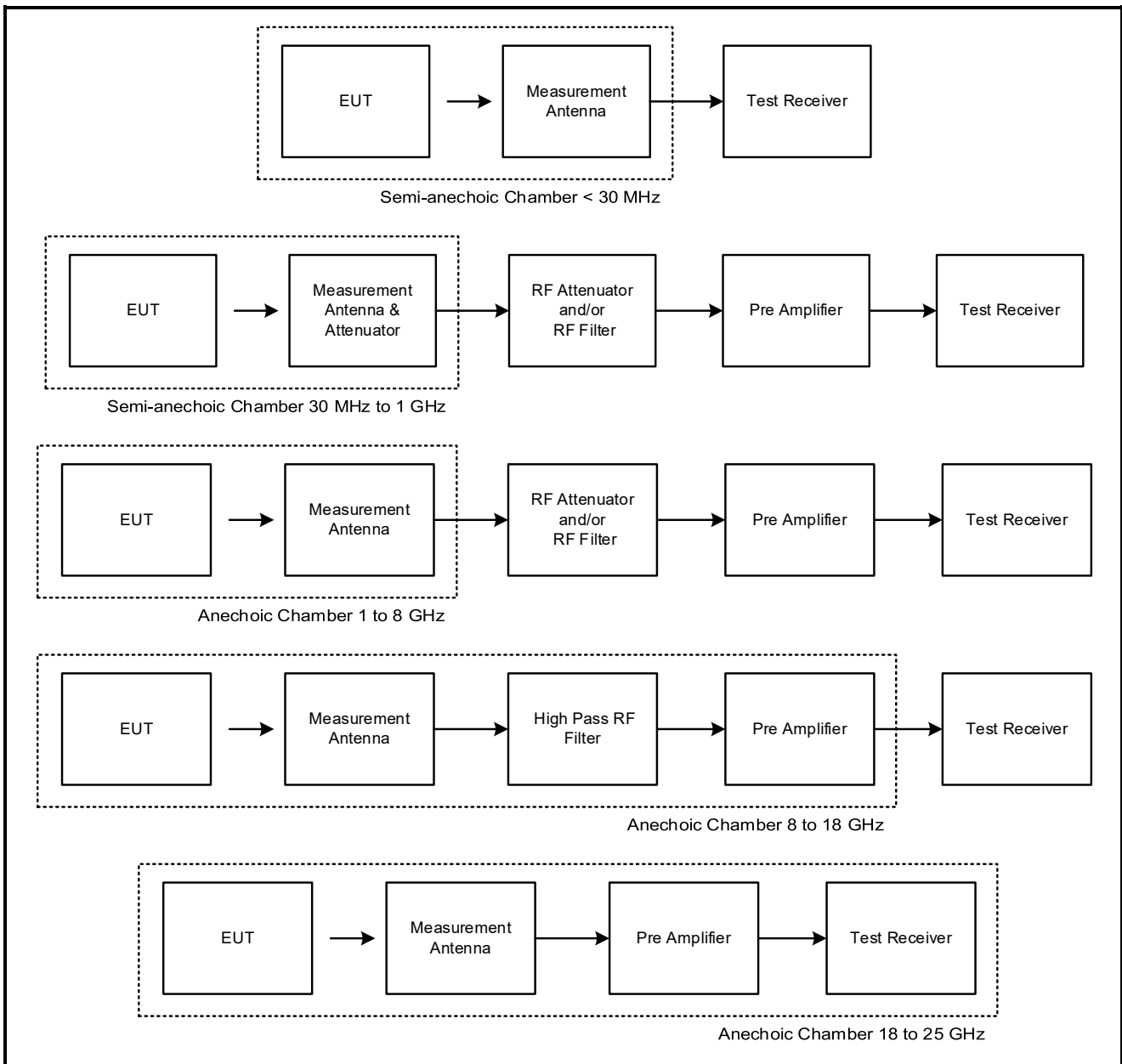
Conducted Tests:

Test Setup for Transmitter 99% Emission Bandwidth, Minimum 6 dB Bandwidth, Power Spectral Density & Maximum Output Power



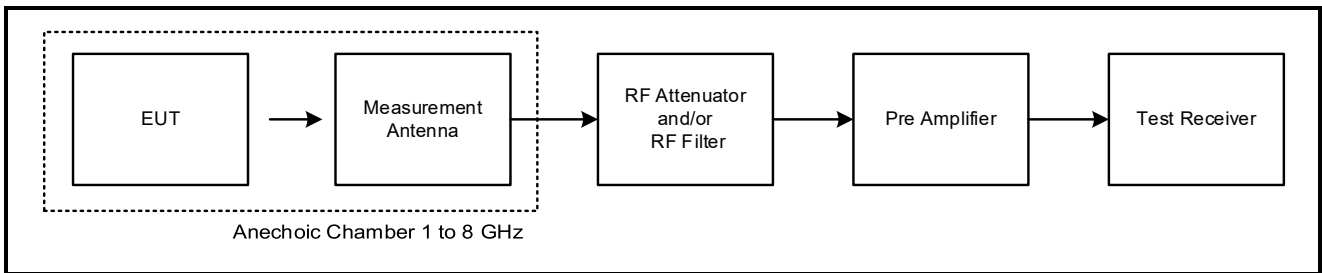
Radiated Tests:

Test Setup for Transmitter Radiated Emissions



Test Setup Diagrams (continued)

Test Setup for Transmitter Duty Cycle & Band Edge Radiated Emissions



4 Antenna Port Test Results

4.1 Transmitter 99% Emission Bandwidth

Test Summary:

Test Engineer:	Jose Bayona	Test Date:	28 April 2023
Test Sample Serial Number:	SXW00047		

FCC Reference:	N/A
ISED Canada Reference:	RSS-Gen 6.7
Test Method Used:	RSS-Gen 6.7

Environmental Conditions:

Temperature (°C):	21
Relative Humidity (%):	47

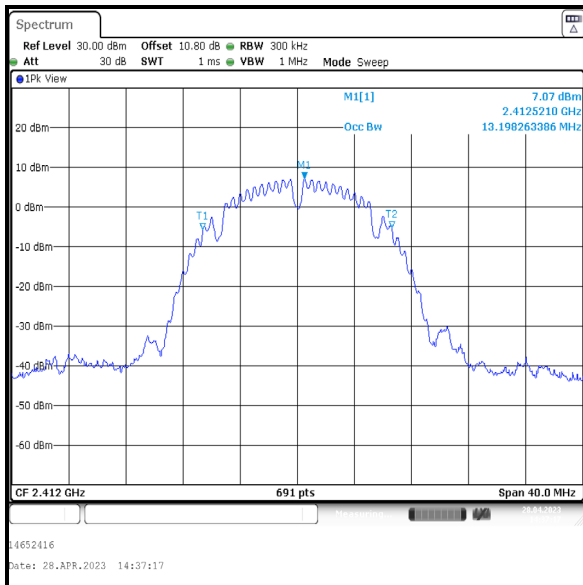
Note(s):

1. The customer declared the following data rates to be used for all measurements as:
 - 802.11b – 1 Mbps
 - 802.11g – 6 Mbps
 - 802.11n HT20 – MCS0
2. Final measurements were performed using the above configurations on the bottom, middle and top channels. The test receiver 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 measured the 99% emission bandwidth.
3. The signal analyser was connected to the RF port on the EUT using suitable attenuation and RF cable. An RF level offset was entered on the signal analyser to compensate for the loss of the attenuator and RF cable.

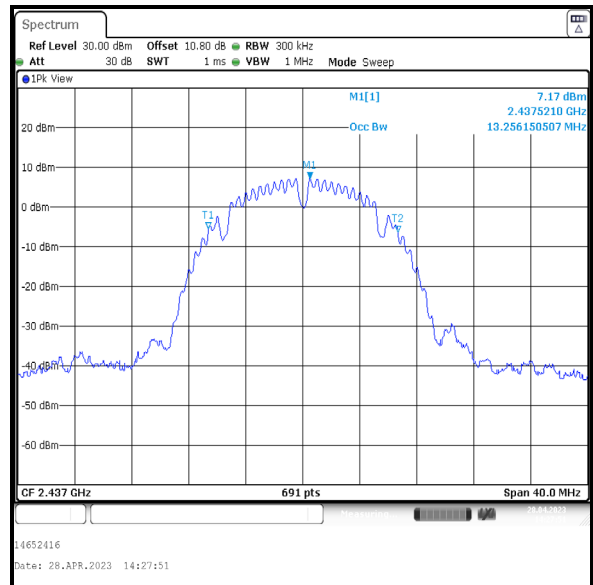
Transmitter 99% Emission Bandwidth (continued)

Results: 802.11b / 20 MHz / SISO / 1 Mbps

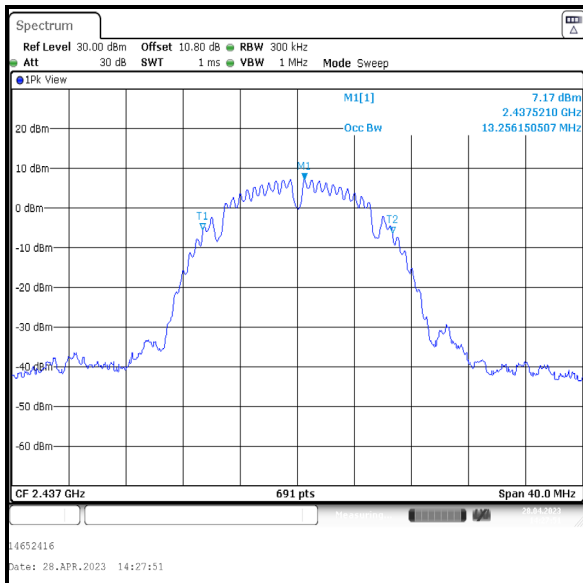
Channel	99% Emission Bandwidth (MHz)
Bottom	13.198
Middle	13.256
Top	13.256



Bottom Channel



Middle Channel

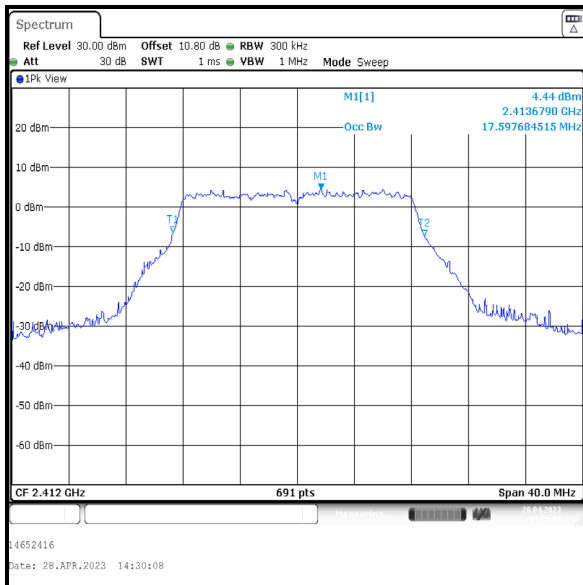


Top Channel

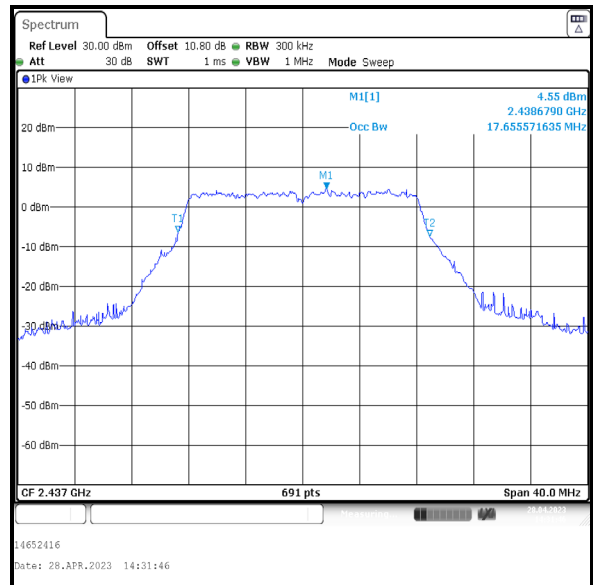
Transmitter 99% Emission Bandwidth (continued)

Results: 802.11g / 20 MHz / SISO / 6 Mbps

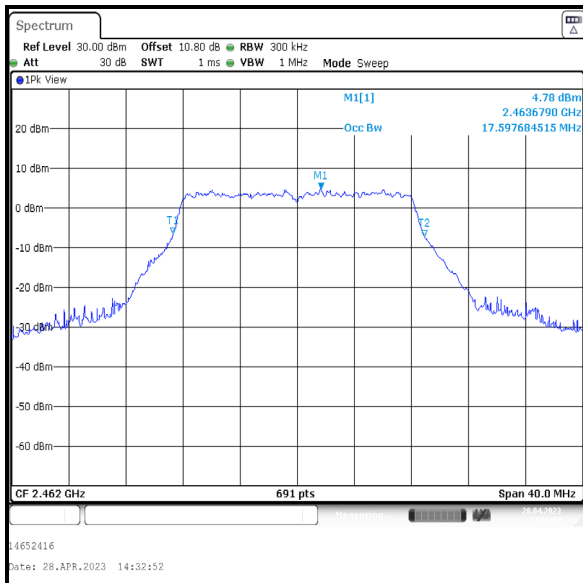
Channel	99% Emission Bandwidth (MHz)
Bottom	17.598
Middle	17.656
Top	17.598



Bottom Channel



Middle Channel

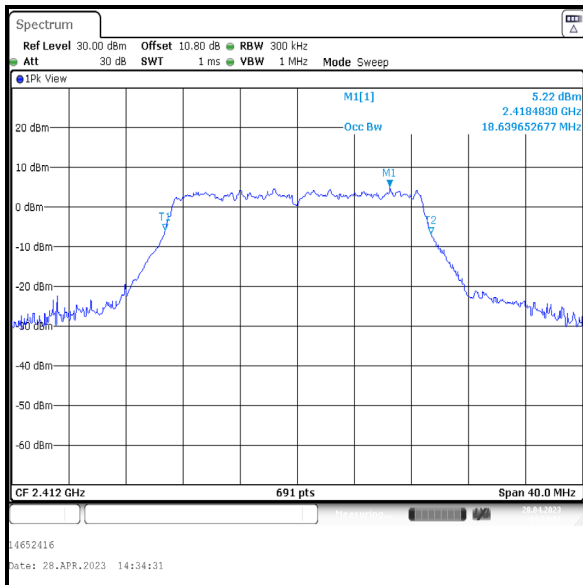


Top Channel

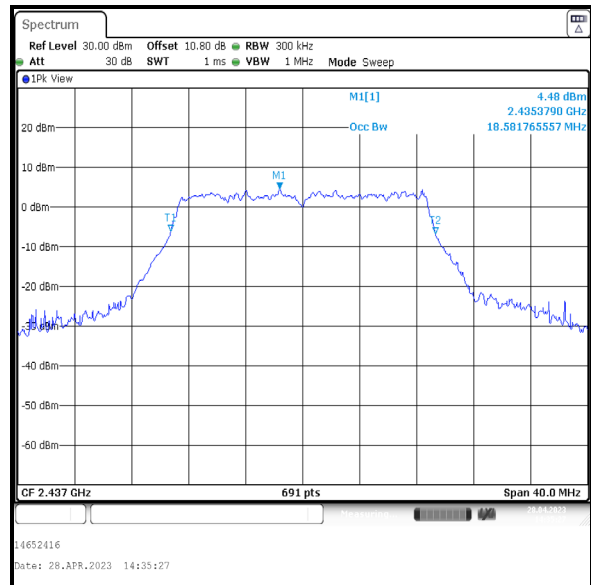
Transmitter 99% Emission Bandwidth (continued)

Results: 802.11n / HT20 / SISO / MCS0

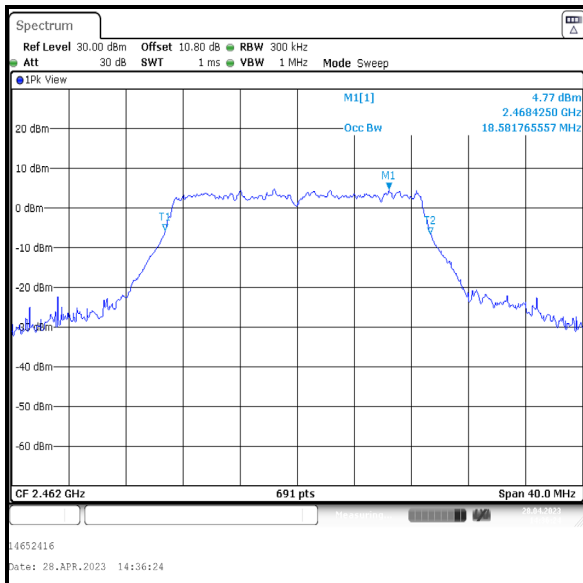
Channel	99% Emission Bandwidth (MHz)
Bottom	18.640
Middle	18.582
Top	18.582



Bottom Channel



Middle Channel



Top Channel

4.2 Transmitter Minimum 6 dB Bandwidth

Test Summary:

Test Engineer:	Jose Bayona	Test Date:	28 April 2023
Test Sample Serial Number:	SXW00047		

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

Environmental Conditions:

Temperature (°C):	21
Relative Humidity (%):	47

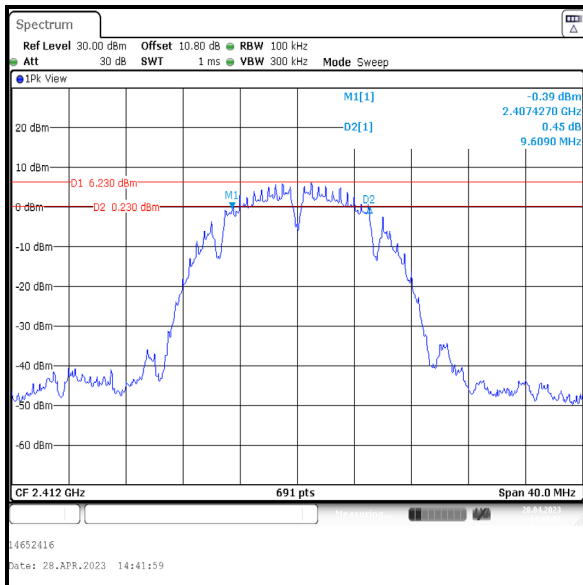
Note(s):

- The customer declared the following data rates to be used for all measurements as:
 - 802.11b – 1 Mbps
 - 802.11g – 6 Mbps
 - 802.11n HT20 – MCS0
- Final measurements were performed using the above configurations on bottom, middle and top channels in accordance with ANSI C63.10 Section 11.8.1 Option 1 measurement procedure. 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 the trace mode was Max Hold. The span was set to 40 MHz. 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 suitable attenuation and RF cable. An RF level offset was entered on the signal analyser to compensate for the loss of the attenuator and RF cable.

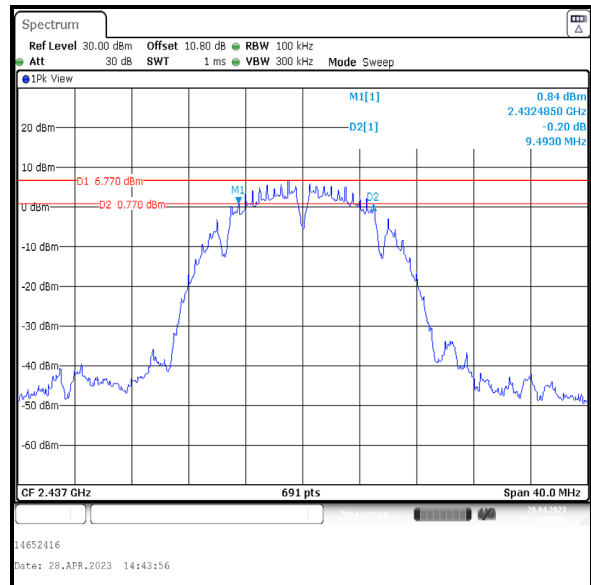
Transmitter Minimum 6 dB Bandwidth (continued)

Results: 802.11b / 20 MHz / SISO / 1 Mbps

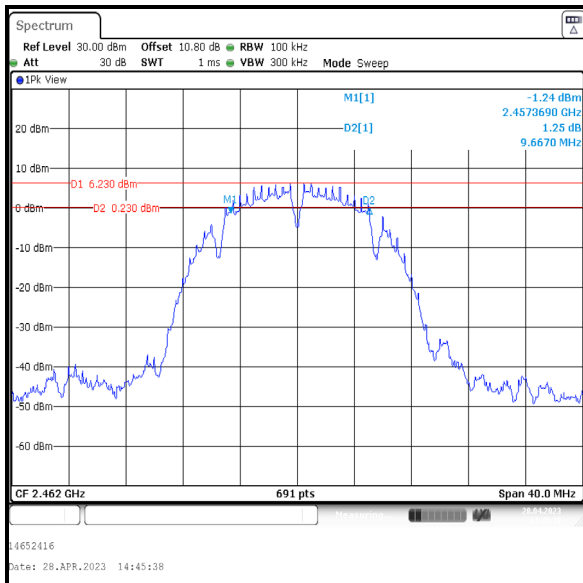
Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
Bottom	9609.000	≥500	9109.000	Complied
Middle	9493.000	≥500	8993.000	Complied
Top	9667.000	≥500	9167.000	Complied



Bottom Channel



Middle Channel

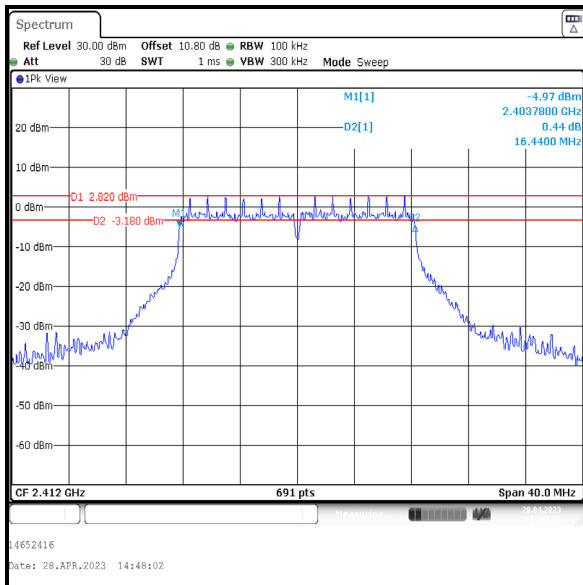


Top Channel

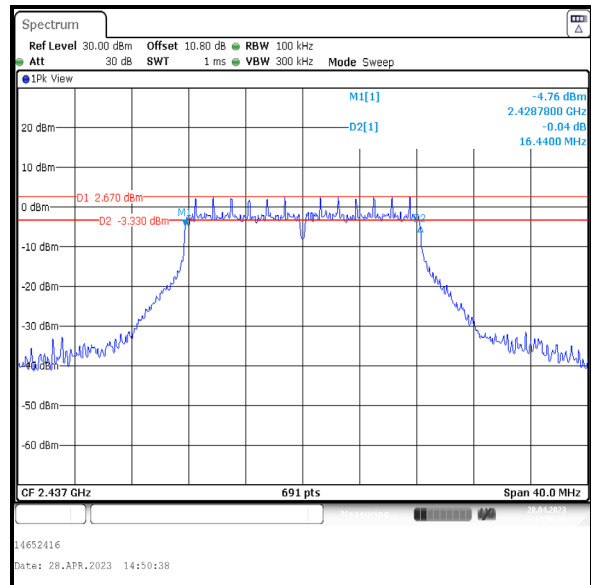
Transmitter Minimum 6 dB Bandwidth (continued)

Results: 802.11g / 20 MHz / SISO / 6 Mbps

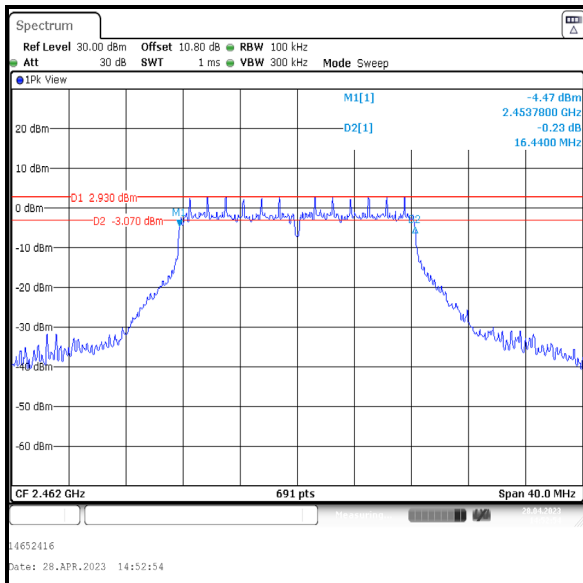
Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
Bottom	16440.000	≥500	15940.000	Complied
Middle	16440.000	≥500	15940.000	Complied
Top	16440.000	≥500	15940.000	Complied



Bottom Channel



Middle Channel

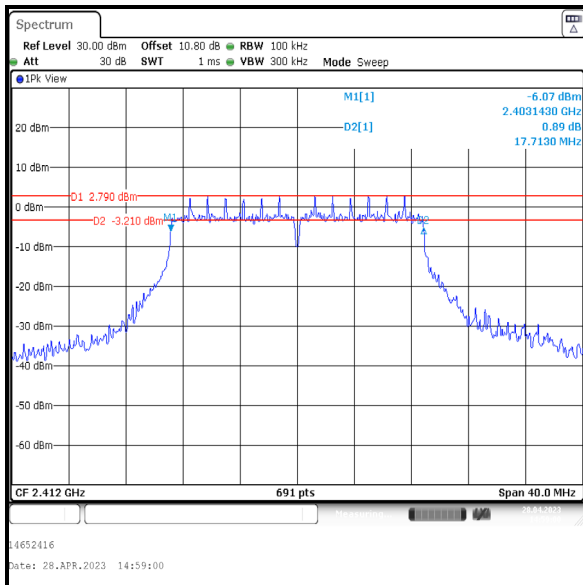


Top Channel

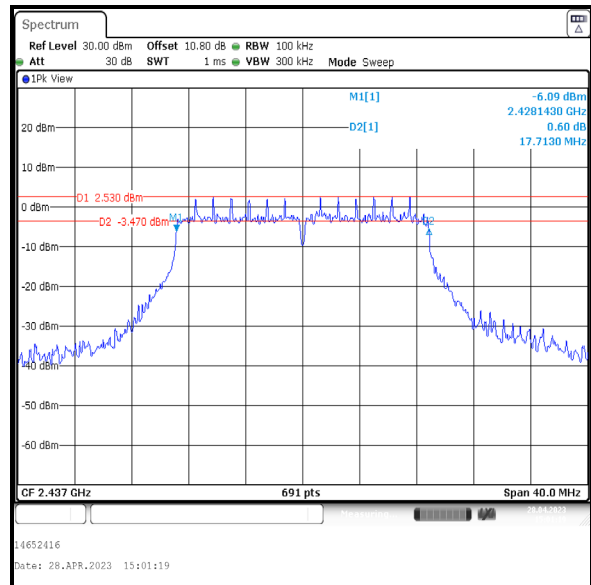
Transmitter Minimum 6 dB Bandwidth (continued)

Results: 802.11n / HT20 / SISO / MCS0

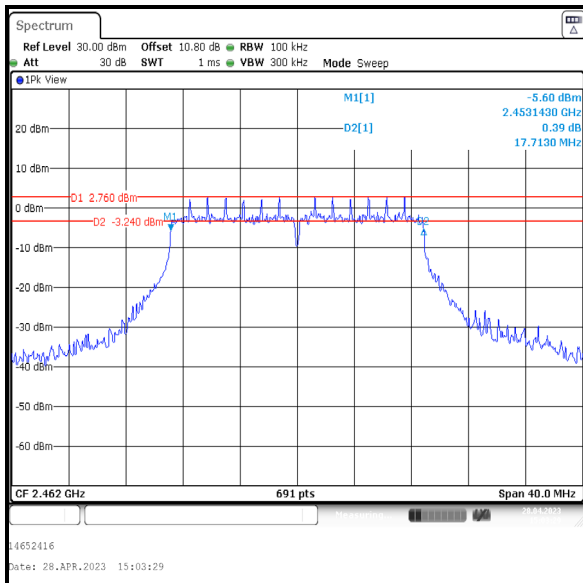
Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
Bottom	17713.000	≥500	15940.000	Complied
Middle	17713.000	≥500	15940.000	Complied
Top	17713.000	≥500	15940.000	Complied



Bottom Channel



Middle Channel



Top Channel

4.3 Transmitter Power Spectral Density

Test Summary:

Test Engineer:	Jose Bayona	Test Date:	28 April 2023
Test Sample Serial Number:	SXW00047		

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

Environmental Conditions:

Temperature (°C):	21
Relative Humidity (%):	47

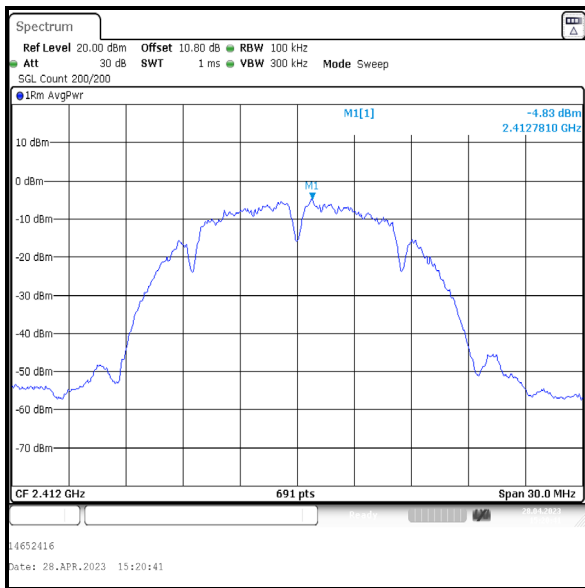
Note(s):

1. The customer declared the following data rates to be used for all measurements as:
 - 802.11b - 1 Mbps
 - 802.11g - 6 Mbps
 - 802.11n HT20 – MCS0
2. Final measurements were performed using the above configurations on bottom, middle and top channels.
3. The EUT was transmitting at <98% duty cycle and testing was performed in accordance with ANSI C63.10 Section 11.10.5 Method AVGPST-2. The signal analyser resolution bandwidth was set to 3 kHz and video bandwidth 10 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 5.1 was added to the measured average power spectral density in order to compute the average power spectral density during the actual transmission time.
4. The signal analyser was connected to the RF port on the EUT using suitable attenuation and RF cable. An RF level offset was entered on the signal analyser to compensate for the loss of the attenuator and RF cable.

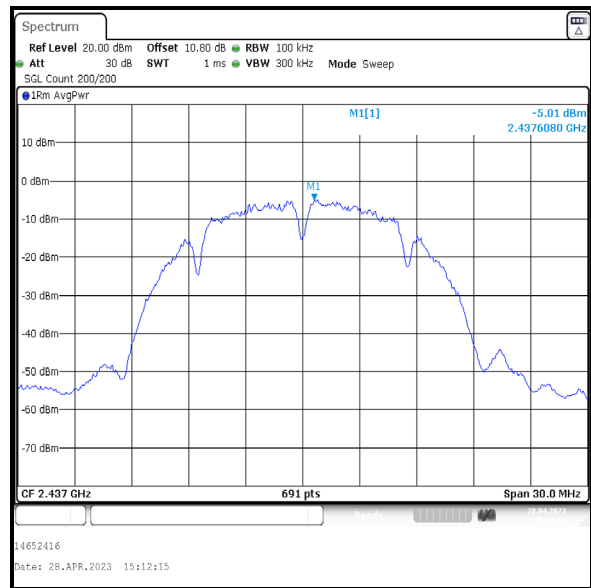
Transmitter Power Spectral Density (continued)

Results: 802.11b / 20 MHz / SISO / 1 Mbps

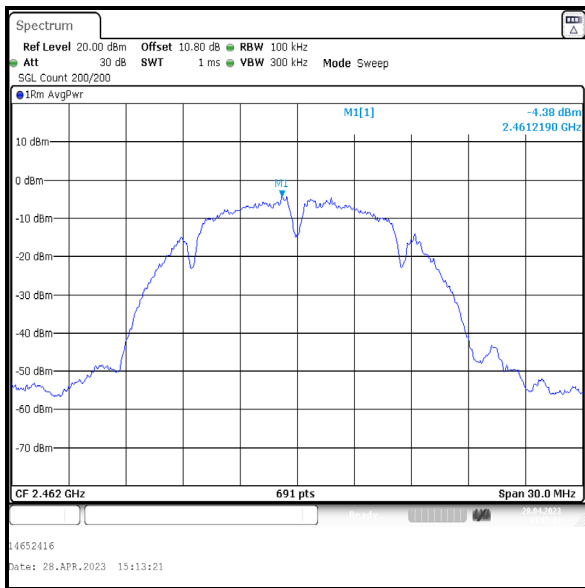
Channel	PSD (dBm/100 kHz)	Duty Cycle Correction (dB)	Corrected PSD (dBm/100 kHz)	Limit (dBm/3 kHz)	Margin (dB)	Result
Bottom	-4.8	3.2	-1.6	8.0	9.6	Complied
Middle	-5.0	3.2	-1.8	8.0	9.8	Complied
Top	-4.4	3.2	-1.2	8.0	9.2	Complied



Bottom Channel



Middle Channel

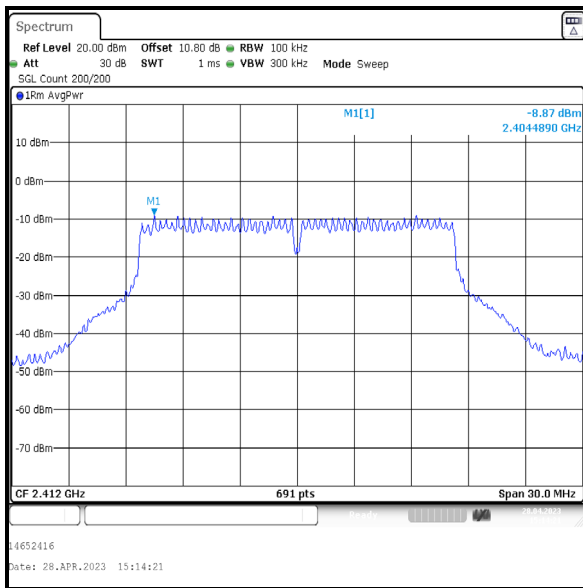


Top Channel

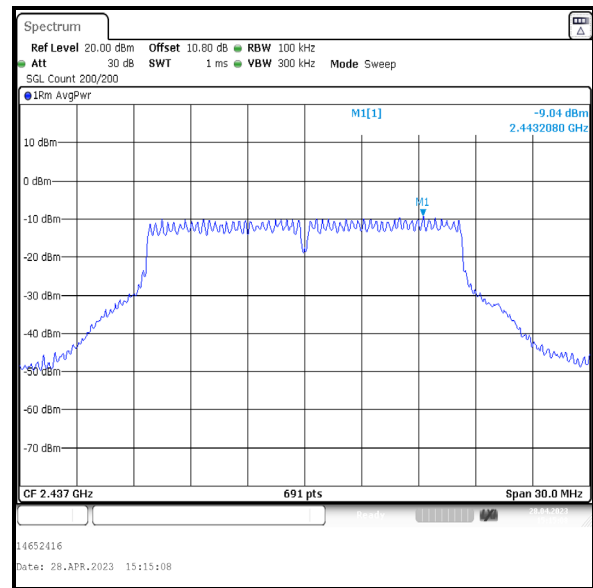
Transmitter Power Spectral Density (continued)

Results: 802.11g / 20 MHz / SISO / 6 Mbps

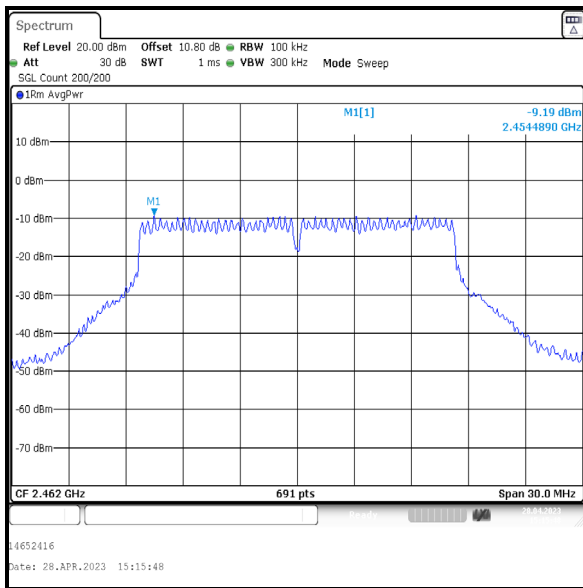
Channel	PSD (dBm/100 kHz)	Duty Cycle Correction (dB)	Corrected PSD (dBm/100 kHz)	Limit (dBm/3 kHz)	Margin (dB)	Result
Bottom	-8.9	3.2	-5.7	8.0	13.7	Complied
Middle	-9.0	3.2	-5.8	8.0	13.8	Complied
Top	-9.2	3.2	-6.0	8.0	14.0	Complied



Bottom Channel



Middle Channel

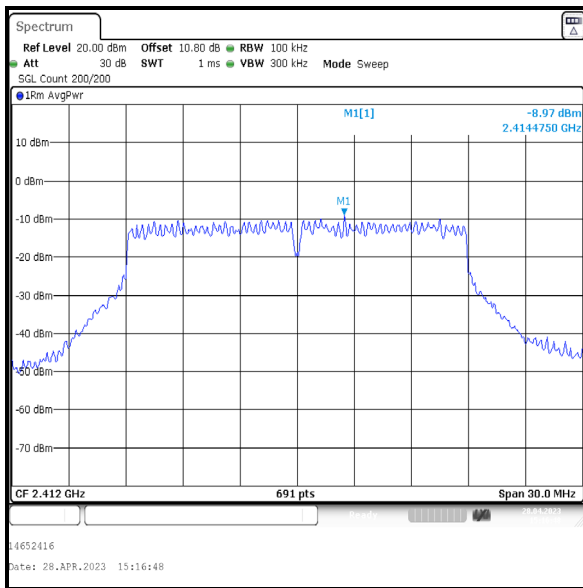


Top Channel

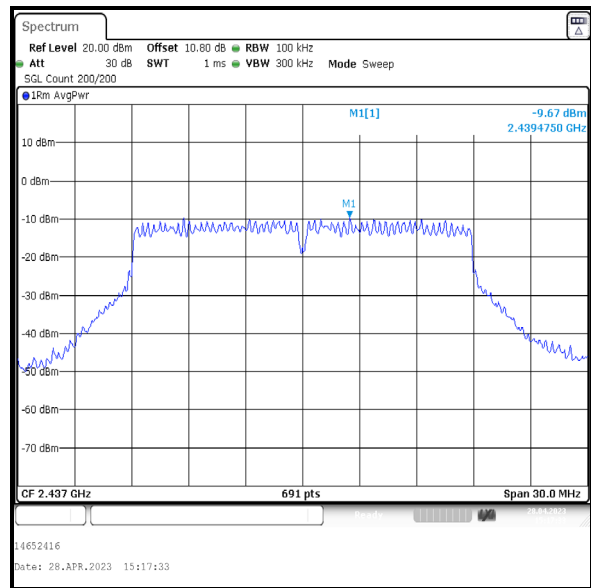
Transmitter Power Spectral Density (continued)

Results: 802.11n / HT20 / SISO / MCS0

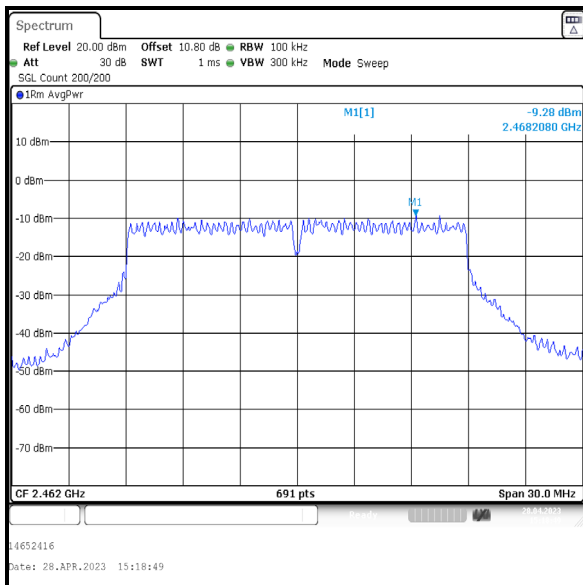
Channel	PSD (dBm/100 kHz)	Duty Cycle Correction (dB)	Corrected PSD (dBm/100 kHz)	Limit (dBm/3 kHz)	Margin (dB)	Result
Bottom	-9.0	3.3	-5.7	8.0	13.7	Complied
Middle	-9.7	3.3	-6.4	8.0	14.4	Complied
Top	-9.3	3.3	-6.0	8.0	14.0	Complied



Bottom Channel



Middle Channel



Top Channel

4.4 Transmitter Maximum (Average) Output Power

Test Summary:

Test Engineer:	Jose Bayona	Test Date:	28 April 2023
Test Sample Serial Number:	SXW00047		

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

Environmental Conditions:

Temperature (°C):	21
Relative Humidity (%):	47

Note(s):

1. The customer declared the following data rates to be used for all measurements as:
 - 802.11b - 1 Mbps
 - 802.11g - 6 Mbps
 - 802.11n HT20 – MCS0
2. Final measurements were performed using the above configurations on bottom, middle and top channels.
3. The power has been integrated over the 99% emission bandwidth as measured in section 4.1 of this report.
4. 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 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. The calculated duty cycle in section 5.1 was added to the measured power in order to compute the average power during the actual transmission time.
5. The signal analyser was connected to the RF port on the EUT using suitable attenuation and RF cable. An RF level offset was entered on the signal analyser to compensate for the loss of the attenuator and RF cable.

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

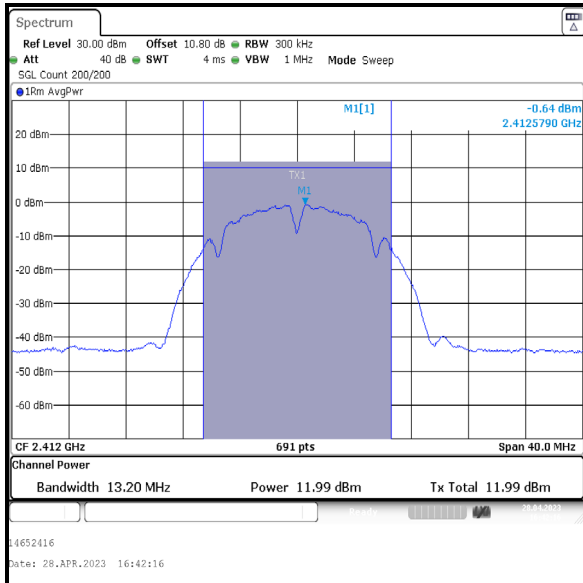
Channel	Conducted Power (dBm)	Duty Cycle Correction Factor (dB)	Corrected Conducted Power (dBm)	Conducted Power Limit (dBm)	Margin (dB)	Result
Bottom	12.0	3.2	15.2	30.0	14.8	Complied
Middle	12.2	3.2	15.4	30.0	14.6	Complied
Top	12.5	3.2	15.7	30.0	14.3	Complied

EIRP Limit Comparison

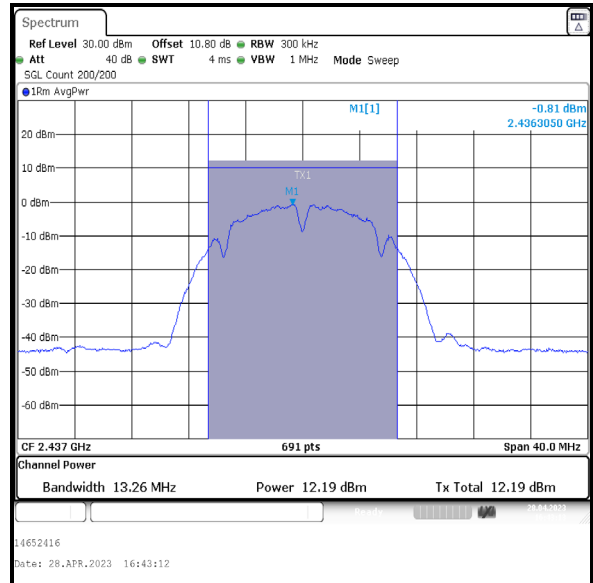
Channel	Corrected Conducted Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
Bottom	15.2	-1.5	13.7	36.0	22.3	Complied
Middle	15.4	-1.5	13.9	36.0	22.1	Complied
Top	15.7	-1.5	14.2	36.0	21.8	Complied

Transmitter Maximum (Average) Output Power (continued)

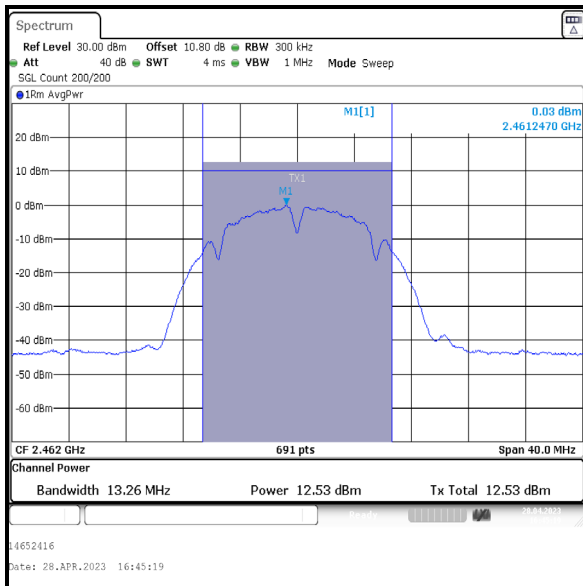
Results: 802.11b / 20 MHz / SISO / 1 Mbps



Bottom Channel



Middle Channel



Top Channel

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

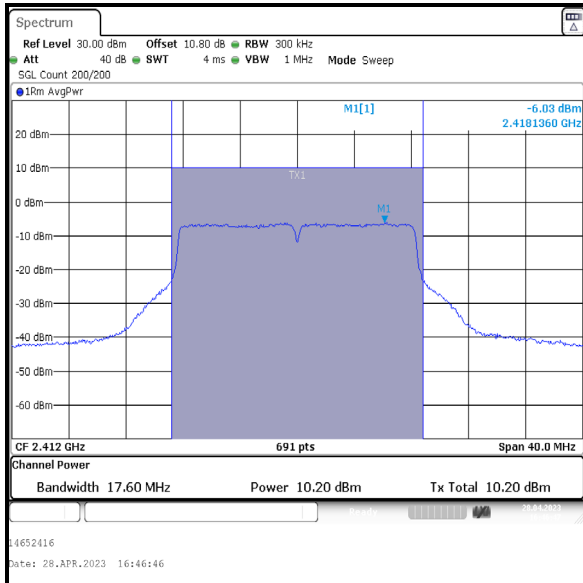
Channel	Conducted Power (dBm)	Duty Cycle Correction Factor (dB)	Corrected Conducted Power (dBm)	Conducted Power Limit (dBm)	Margin (dB)	Result
Bottom	10.2	3.2	13.4	30.0	16.6	Complied
Middle	10.2	3.2	13.4	30.0	16.6	Complied
Top	10.3	3.2	13.5	30.0	16.5	Complied

EIRP Limit Comparison

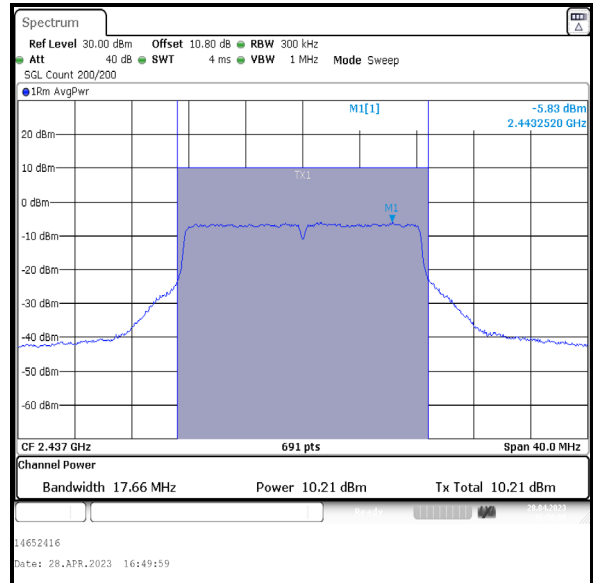
Channel	Corrected Conducted Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
Bottom	13.4	-1.5	11.9	36.0	24.1	Complied
Middle	13.4	-1.5	11.9	36.0	24.1	Complied
Top	13.5	-1.5	12.0	36.0	24.0	Complied

Transmitter Maximum (Average) Output Power (continued)

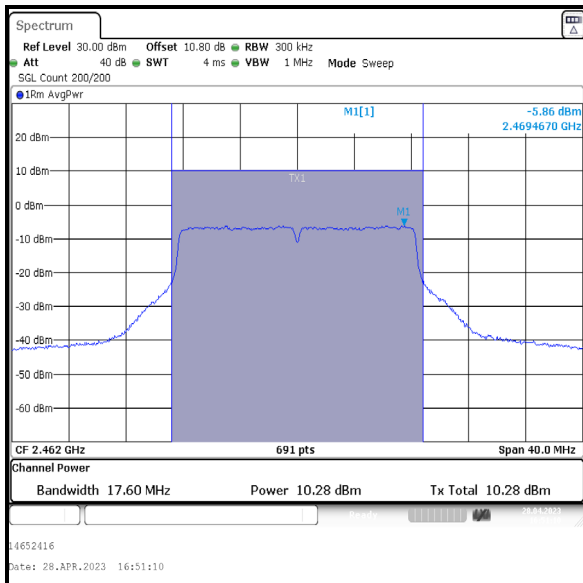
Results: 802.11g / 20 MHz / SISO / 6 Mbps



Bottom Channel



Middle Channel



Top Channel

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

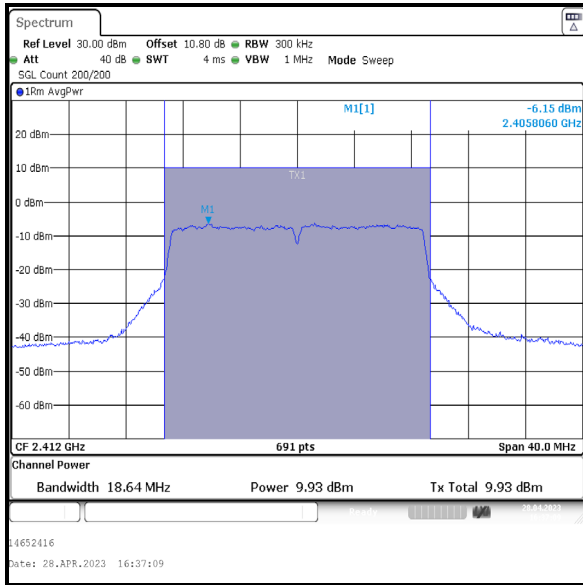
Channel	Conducted Power (dBm)	Duty Cycle Correction Factor (dB)	Corrected Conducted Power (dBm)	Conducted Power Limit (dBm)	Margin (dB)	Result
Bottom	9.9	3.3	13.2	30.0	16.8	Complied
Middle	10.2	3.3	13.5	30.0	16.5	Complied
Top	10.3	3.3	13.6	30.0	16.4	Complied

EIRP Limit Comparison

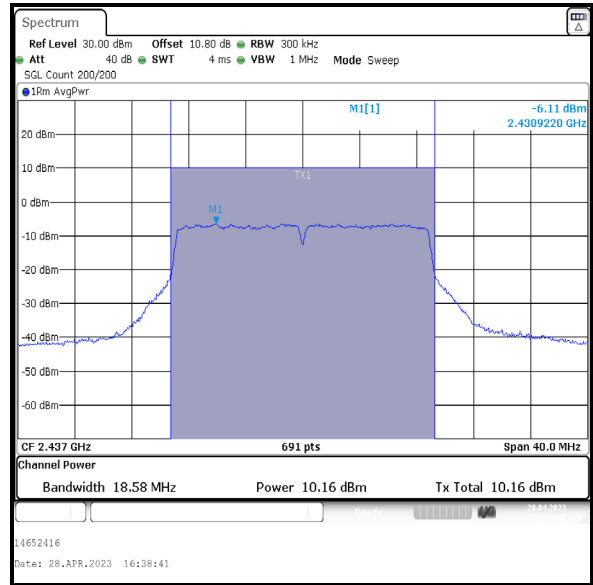
Channel	Corrected Conducted Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
Bottom	13.2	-1.5	11.7	36.0	24.3	Complied
Middle	13.5	-1.5	12.0	36.0	24.0	Complied
Top	13.6	-1.5	12.1	36.0	23.9	Complied

Transmitter Maximum (Average) Output Power (continued)

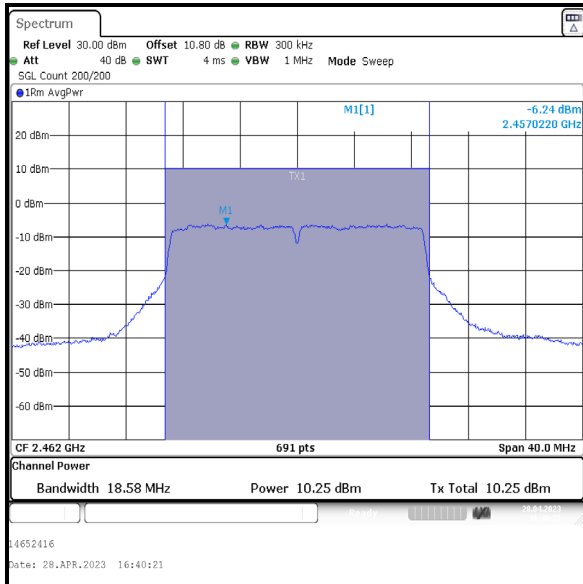
Results: 802.11n / HT20 / SISO / MCS0



Bottom Channel



Middle Channel



Top Channel

5 Radiated Test Results

5.1 Transmitter Duty Cycle

Test Summary:

Test Engineer:	John Ferdinand	Test Date:	27 February 2023
Test Sample Serial Number:	SXW00036		

FCC Reference:	Part 15.35(c)
ISED Canada Reference:	RSS-Gen 6.10
Test Method Used:	FCC KDB 558074 Section 6 referencing ANSI C63.10 Section 11.6

Environmental Conditions:

Temperature (°C):	19
Relative Humidity (%):	41

Note(s):

- 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:

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

$$802.11g / 20 \text{ MHz} / 6 \text{ Mbps duty cycle } 10 \log (1 / (0.584/1.233)) = 3.2 \text{ dB}$$

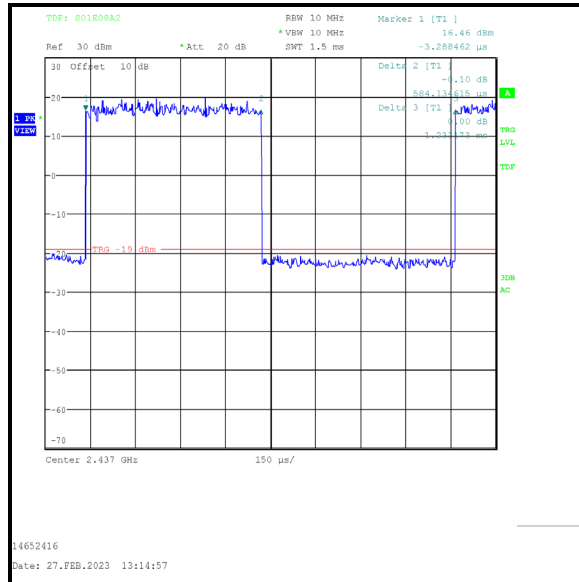
$$802.11b / 20 \text{ MHz} / 1 \text{ Mbps duty cycle: } 10 \log (1 / (0.591/1.240)) = 3.2 \text{ dB}$$

$$802.11n / HT20 / MCS0 \text{ duty cycle: } 10 \log (1 / (0.563/1.209)) = 3.3 \text{ dB}$$

Transmitter Duty Cycle (continued)

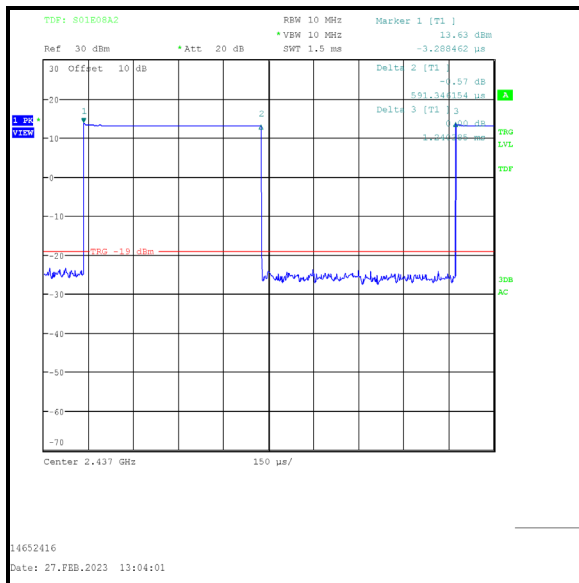
Results: 802.11g / 20 MHz / 6 Mbps

Pulse Duration (ms)	Period (ms)	Duty Cycle (dB)
0.584	1.233	3.2



Results: 802.11b / 20 MHz / 1 Mbps

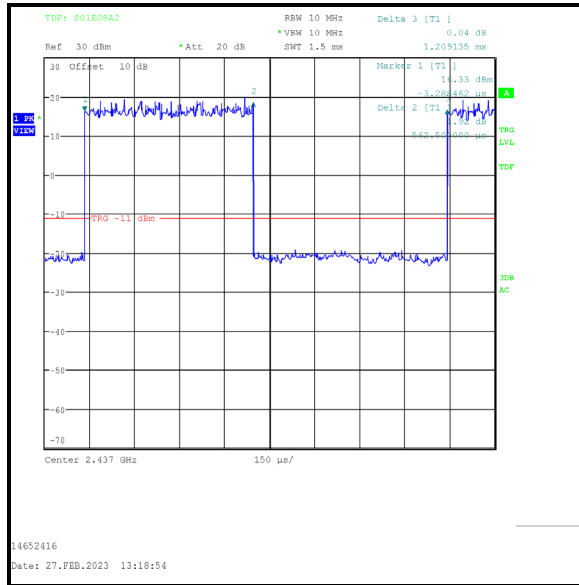
Pulse Duration (ms)	Period (ms)	Duty Cycle (dB)
0.591	1.240	3.2



Transmitter Duty Cycle (continued)

Results: 802.11n / HT20 / MCS0

Pulse Duration (ms)	Period (ms)	Duty Cycle (dB)
0.563	1.209	3.3



5.2 Transmitter Radiated Emissions <1 GHz

Test Summary:

Test Engineers:	Robert English & John Ferdindand	Test Dates:	07 March 2023 & 08 March 2023
Test Sample Serial Numbers:	SXW00036 & SXW00037		

FCC Reference:	Parts 15.247(d) & 15.209(a)
ISED Canada Reference:	RSS-Gen 6.13 / RSS-247 5.5
Test Method Used:	ANSI C63.10 Sections 6.3 and 6.5
Frequency Range	9 kHz to 1000 MHz

Environmental Conditions:

Temperature (°C):	20 to 21
Relative Humidity (%):	33 to 36

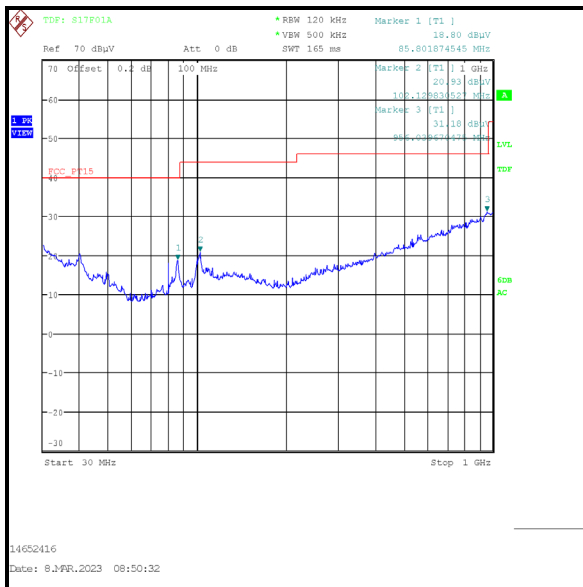
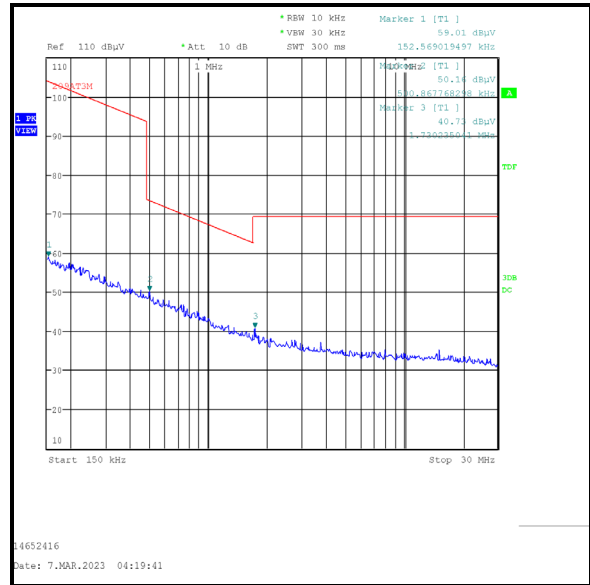
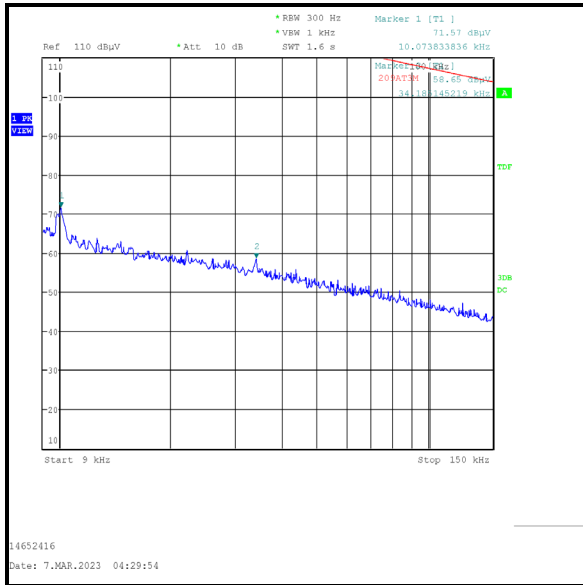
Note(s):

1. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
2. The preliminary scans showed similar emission levels below 1 GHz, for each channel of operation. Therefore final radiated emissions measurements were performed with the EUT set to the middle channel only.
3. All emissions shown on the pre-scan plots were investigated and found to be ambient, >20 dB below the applicable limit or below the measurement system noise floor. Therefore the highest peak noise floor reading of the measuring receiver was recorded in the table below.
4. Measurements below 30 MHz were performed in a semi-anechoic chamber (Asset Number K0001) at 3 metres. The EUT was placed at a height of 80 cm above the reference ground plane in the centre of the chamber turntable. The limit was extrapolated to 3 metres in accordance with ANSI C63.10 Section 6.4.4.2. Correlation data between the semi-anechoic chamber and an open-field test site is available upon request.
5. The limits in CFR 47, Part 15, Subpart C, paragraph 15.209 (a), are identical to those in RSS-Gen Section 8.9, Table 6, since the measurements are performed in terms of magnetic field strength and converted to electric field strength levels (as reported in the table) using the free space impedance of 377Ω . For example, the measurement frequency X kHz resulted in a level of Y dB μ V/m, which is equivalent to $Y - 51.5 = Z$ dB μ A/m, which has the same margin, W dB, to the corresponding RSS-Gen Table 6 limit as it has to the 15.209(a) limit.
6. Measurements between 30 MHz to 1 GHz were performed in a semi-anechoic chamber (Asset Number K0017) at a distance of 3 metres. The EUT was placed at a height of 80 cm above the reference ground plane in the centre of the chamber turntable. Maximum emission levels were determined by height searching the measurement antenna over the range 1 metre to 4 metres.
7. Pre-scans were performed and markers placed on the highest measured levels. The test receiver was configured as follows: During 9 kHz to 150 kHz tests, the resolution bandwidth was set to 300 Hz and video bandwidth 1 kHz. A peak detector was used and trace mode was Max Hold. For 150 kHz to 30 MHz, the resolution bandwidth was set to 10 kHz and video bandwidth 30 kHz. A peak detector was used and trace mode was Max Hold. For 30 MHz to 1 GHz, the resolution bandwidth was set to 120 kHz and video bandwidth 500 kHz. A peak detector was used, sweep time was set to auto and trace mode was Max Hold.

Transmitter Radiated Emissions (continued)

Results: Middle Channel / 802.11g / 6 Mbps

Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
956.040	Vertical	31.2	46.0	14.8	Complied



Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

5.3 Transmitter Radiated Emissions >1 GHz

Test Summary:

Test Engineers:	John Ferdinand & Robert English	Test Dates:	27 February 2023 to 01 March 2023
Test Sample Serial Numbers:	SXW00036 & SXW00037		

FCC Reference:	Parts 15.247(d) & 15.209(a)
ISED Canada Reference:	RSS-Gen 6.13 & 8.9 / RSS-247 5.5
Test Method Used:	FCC KDB 558074 Sections 8.5 & 8.6 referencing ANSI C63.10 Sections 6.3, 6.6, 11.11, 11.12.2.4 & 11.12.2.5.2
Frequency Range	1 GHz to 25 GHz

Environmental Conditions:

Temperature (°C):	19 to 21
Relative Humidity (%):	36 to 41

Note(s):

1. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
2. All other emissions shown on the pre-scans were investigated and found to be ambient, >20 dB below the applicable limit or below the noise floor of the measurement system.
3. The emission shown approximately at 2437 MHz on the 1 GHz to 3 GHz plot is the EUT fundamental.
4. Pre-scans above 1 GHz were performed in a fully anechoic chamber (Asset Number K0001) at a distance of 3 metres. The EUT was placed at a height of 1.5 metres above the test chamber floor in the centre of the chamber turntable. All measurement antennas were placed at a fixed height of 1.5 metres above the test chamber floor, in line with the EUT. Final measurements above 1 GHz were performed in a semi-anechoic chamber (Asset Number K0001) at a distance of 3 metres. The EUT was placed at a height of 1.5 m above the reference ground plane in the centre of the chamber turntable. Maximum emission levels were determined by height searching the measurement antenna over the range 1 metre to 4 metres.
5. Pre-scans were performed and a marker placed on the highest measured level of the appropriate plot. The test receiver resolution bandwidth was set to 1 MHz and video bandwidth 3 MHz. The sweep time was set to auto.
6. *-30 dBc limit applies in non-restricted bands as the conducted average maximum output power was previously measured.
7. The reference level for emissions in non-restricted bands was established following KDB 558074 Section 11.2 procedure.
8. The EUT had a duty cycle <98%, therefore the duty cycle correction factor calculated in Section 4.1 has been applied.

Transmitter Radiated Emissions (continued)**Results: Bottom Channel / Peak**

Frequency (MHz)	Antenna Polarity	Peak Level (dB μ V/m)	Peak Limit (dB μ V/m)	Margin (dB)	Result
3215.990	Vertical	47.5	63.0*	15.5	Complied
4817.800	Horizontal	59.2	74.0	14.8	Complied

Results: Bottom Channel / Average

Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Duty cycle correction (dB)	Corrected Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
4825.480	Horizontal	45.2	3.2	48.4	54.0	5.6	Complied

Results: Middle Channel / Peak

Frequency (MHz)	Antenna Polarity	Peak Level (dB μ V/m)	Peak Limit (dB μ V/m)	Margin (dB)	Result
3249.308	Vertical	46.7	63.0*	16.3	Complied
4873.960	Horizontal	60.0	74.0	14.0	Complied
7313.600	Horizontal	56.7	74.0	17.3	Complied

Results: Middle Channel / Average

Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Duty cycle correction (dB)	Corrected Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
4874.760	Horizontal	45.7	3.2	48.9	54.0	5.1	Complied
7311.280	Horizontal	39.0	3.2	39.0	42.2	11.8	Complied

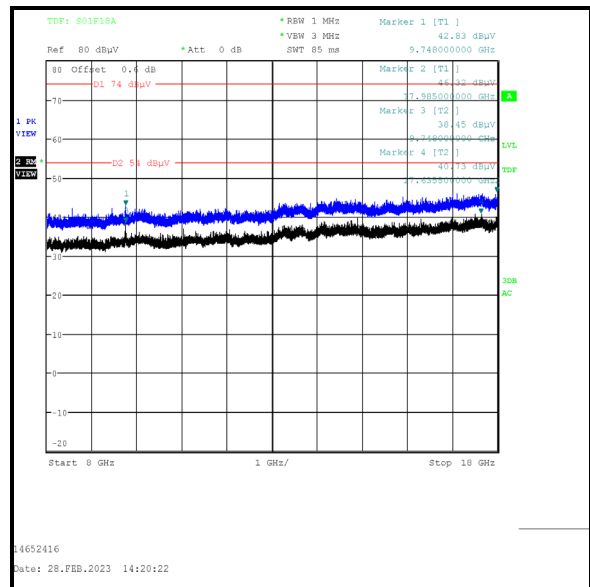
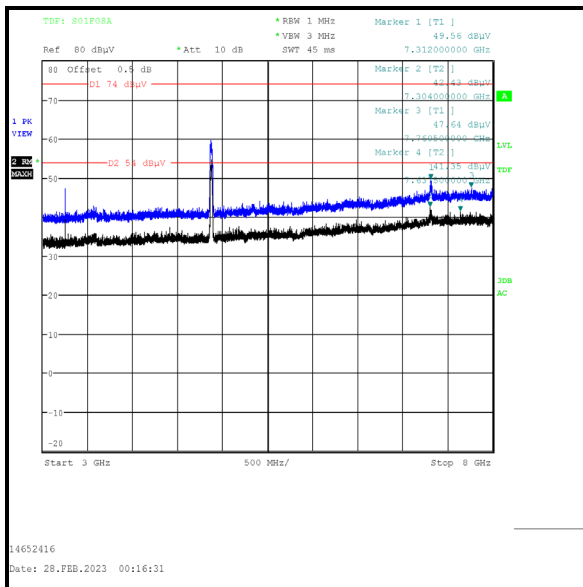
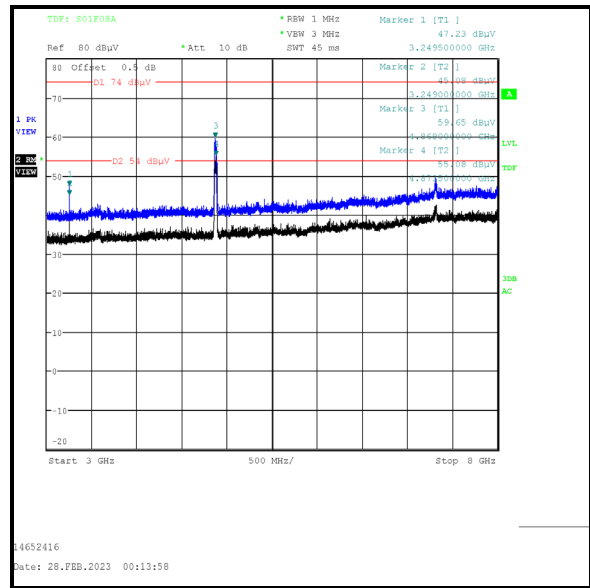
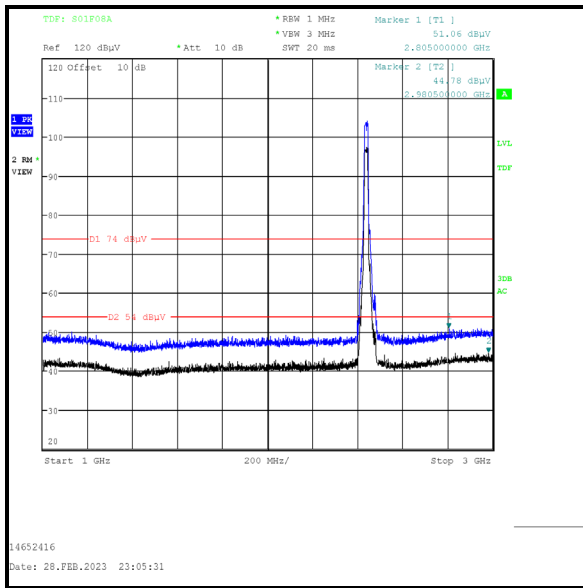
Results: Top Channel / Peak

Frequency (MHz)	Antenna Polarity	Peak Level (dB μ V/m)	Peak Limit (dB μ V/m)	Margin (dB)	Result
3282.631	Vertical	47.2	63.0*	15.8	Complied
4917.880	Horizontal	60.6	74.0	13.4	Complied
7385.200	Horizontal	56.8	74.0	17.2	Complied

Results: Top Channel / Average

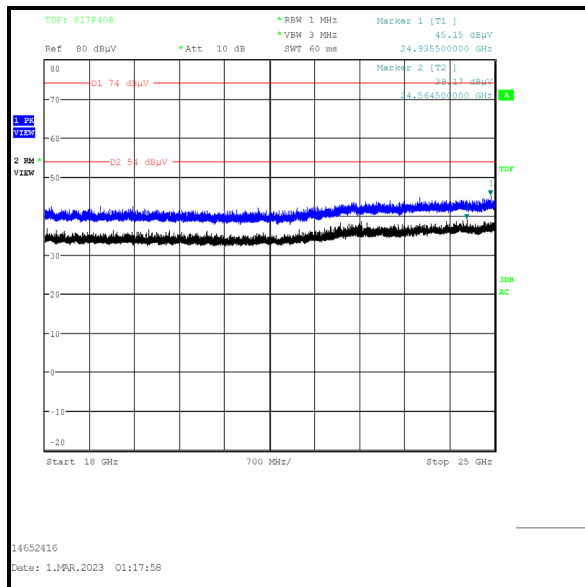
Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Duty cycle correction (dB)	Corrected Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
4925.240	Horizontal	46.0	3.2	49.2	54.0	4.8	Complied
7383.400	Horizontal	40.5	3.2	43.7	54.0	10.3	Complied

Transmitter Radiated Emissions (continued)



Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

Transmitter Radiated Emissions (continued)



Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

5.4 Transmitter Band Edge Radiated Emissions

Test Summary:

Test Engineer:	John Ferdinand	Test Date:	28 February 2023
Test Sample Serial Number:	SXW00037		

FCC Reference:	Parts 15.247(d) & 15.209(a)
ISED Canada Reference:	RSS-Gen 6.13 & 8.9 / RSS-247 5.5
Test Method Used:	KDB 558074 Section 8.7 referencing ANSI C63.10 Sections 6.10, 11.11, 11.12 & 11.13

Environmental Conditions:

Temperature (°C):	21
Relative Humidity (%):	38

Transmitter Band Edge Radiated Emissions (continued)**Note(s):**

1. The customer declared the following data rates to be used for all measurements as:

- 802.11b / 1 Mbps
- 802.11g / 6 Mbps
- 802.11n HT20 / MCS0

Final measurements were performed with the above configurations.

2. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
3. The maximum conducted (average) output power was previously measured. In accordance with ANSI C63.10 Section 11.11.1(b), the lower band edge measurement should be performed with a peak detector and the -30 dBc limit applied.
4. As the lower band edge is adjacent to a non-restricted band, only peak measurements are required. In accordance with ANSI C63.10 Section 11.11.1, 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 ANSI C63.10 Section 11.9.2.2.2 or 11.9.2.2.4 an out-of-band limit line was placed 30 dB (ANSI C63.10 Section 11.11.1(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.
5. As the upper band edge is adjacent to a restricted band both peak and average measurements were recorded by placing a marker at the edge of the band. For peak measurements the test receiver resolution bandwidth was set to 1 MHz and the video bandwidth 3 MHz. A peak detector was used, sweep time was set to auto and trace mode was Max Hold. For average measurements the test receiver resolution bandwidth was set to 1 MHz and the video bandwidth 3 MHz. An RMS detector was used, sweep time was set to auto and trace mode was trace averaging over 300 sweeps. A marker was placed on the band edge spot frequencies and a second marker placed on the highest emission level in the adjacent restricted band of operation (where a higher level emission was present). Marker frequencies and levels were recorded.
6. * -30 dBc limit.
7. There is a restricted band 10 MHz below the lower band edge. The test receiver was set up as follows: the RBW set to 1 MHz, the VBW set to 3 MHz, with the sweep time set to auto couple. Peak and average measurements were performed with their respective detectors. Markers were placed on the highest point on each trace.
8. For the upper band edge average result, the EUT had a duty cycle <98%. The duty cycle correction factor calculated in Section 4.1 has been applied.

Transmitter Band Edge Radiated Emissions (continued)**Results: 802.11b / 20 MHz / 1 Mbps****Results: Lower Band Edge**

Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	-30 dBc Limit (dB μ V/m)	Margin (dB)	Result
2397.997	Horizontal	50.7	66.1*	15.4	Complied
2400	Horizontal	41.0	66.1*	25.1	Complied

Results: Upper Band Edge / Peak

Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2483.5	Horizontal	41.1	74.0	32.9	Complied
2484.623	Horizontal	52.8	74.0	21.2	Complied

Results: Upper Band Edge / Average

Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Duty cycle correction (dB)	Corrected Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2483.5	Horizontal	41.1	3.2	44.3	54.0	9.7	Complied

Results: 2310 MHz to 2390 MHz Restricted Band / Peak

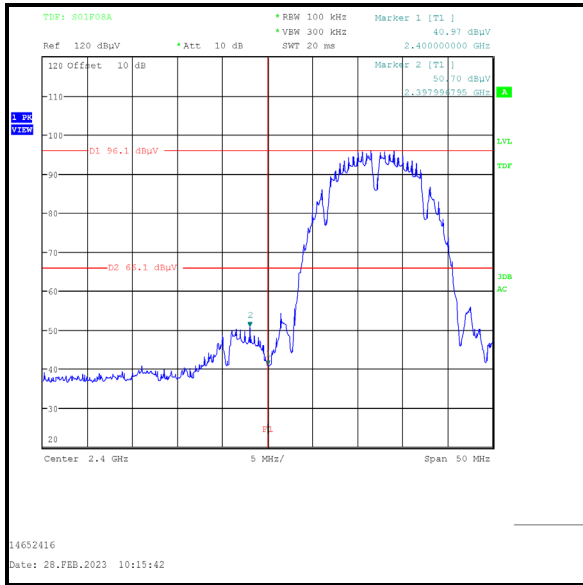
Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2386.538	Horizontal	50.3	74.0	23.7	Complied

Results: 2310 MHz to 2390 MHz Restricted Band / Average

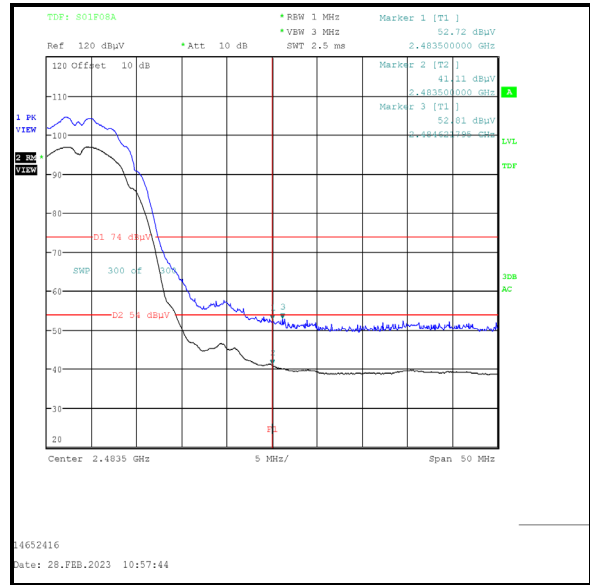
Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Duty cycle correction (dB)	Corrected Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2386.538	Horizontal	38.6	3.2	41.8	54.0	12.2	Complied

Transmitter Band Edge Radiated Emissions (continued)

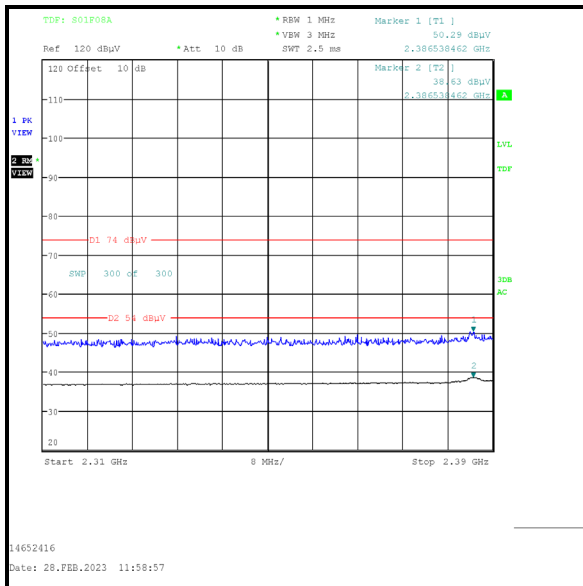
Results: 802.11b / 20 MHz / 1 Mbps



Lower Band Edge



Upper Band Edge



2310 MHz to 2390 MHz Restricted Band

Transmitter Band Edge Radiated Emissions (continued)**Results: 802.11g / 20 MHz / 6 Mbps****Results: Lower Band Edge**

Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	-30 dBc Limit (dB μ V/m)	Margin (dB)	Result
2399.119	Horizontal	58.7	63.0*	4.3	Complied
2400	Horizontal	55.7	63.0*	7.3	Complied

Results: Upper Band Edge / Peak

Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2483.5	Horizontal	66.7	74.0	7.3	Complied

Results: Upper Band Edge / Average

Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Duty cycle correction (dB)	Corrected Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2483.5	Horizontal	49.2	3.2	52.4	54.0	1.6	Complied

Results: 2310 MHz to 2390 MHz Restricted Band / Peak

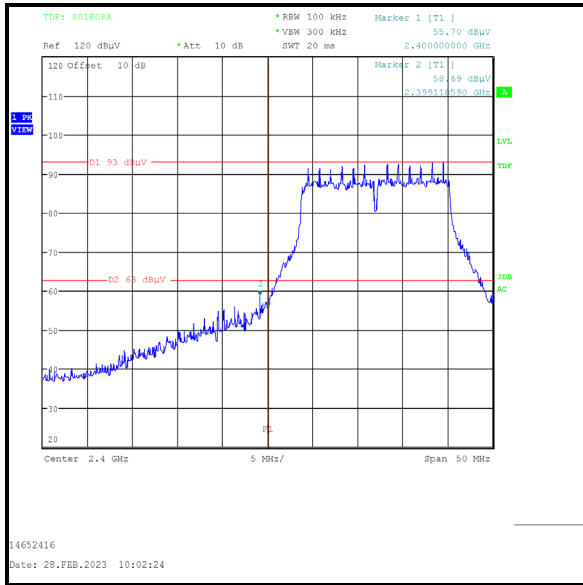
Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2390.000	Horizontal	63.2	74.0	10.8	Complied

Results: 2310 MHz to 2390 MHz Restricted Band / Average

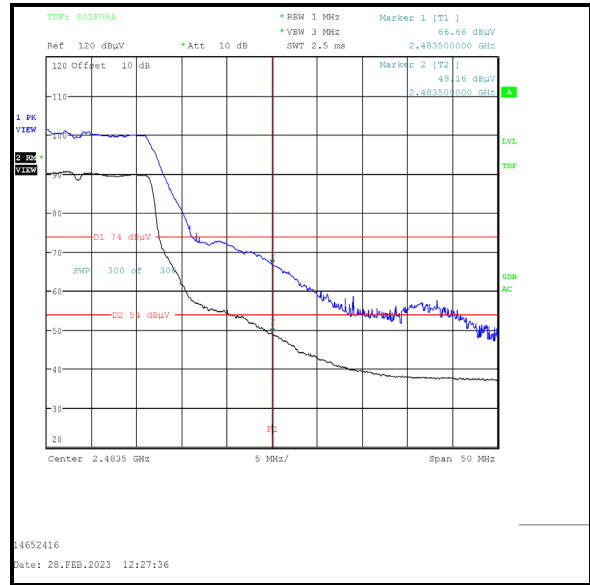
Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Duty cycle correction (dB)	Corrected Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2390.000	Horizontal	45.9	3.2	49.1	54.0	4.9	Complied

Transmitter Band Edge Radiated Emissions (continued)

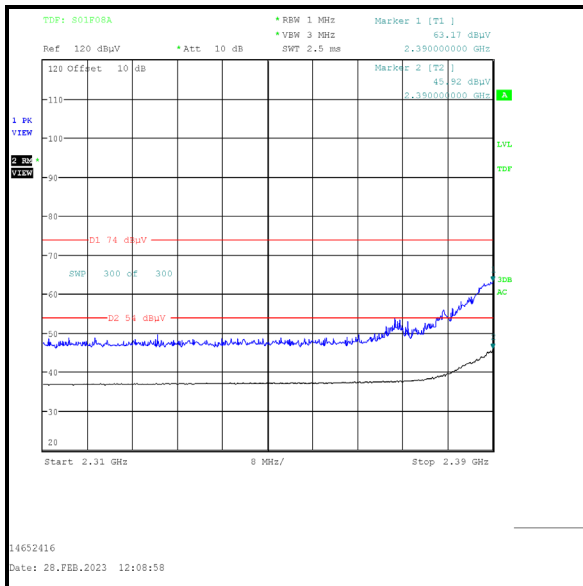
Results: 802.11g / 20 MHz / 6 Mbps



Lower Band Edge



Upper Band Edge



2310 MHz to 2390 MHz Restricted Band

Transmitter Band Edge Radiated Emissions (continued)**Results: 802.11n HT20 / 20 MHz / MCS0****Results: Lower Band Edge**

Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	-30 dBc Limit (dB μ V/m)	Margin (dB)	Result
2399.760	Horizontal	61.0	63.4*	2.4	Complied
2400	Horizontal	57.4	63.4*	6.0	Complied

Results: Upper Band Edge / Peak

Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2483.5	Horizontal	68.5	74.0	5.5	Complied

Results: Upper Band Edge / Average

Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Duty cycle correction (dB)	Corrected Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2483.5	Horizontal	50.2	3.3	53.5	54.0	0.5	Complied

Results: 2310 MHz to 2390 MHz Restricted Band / Peak

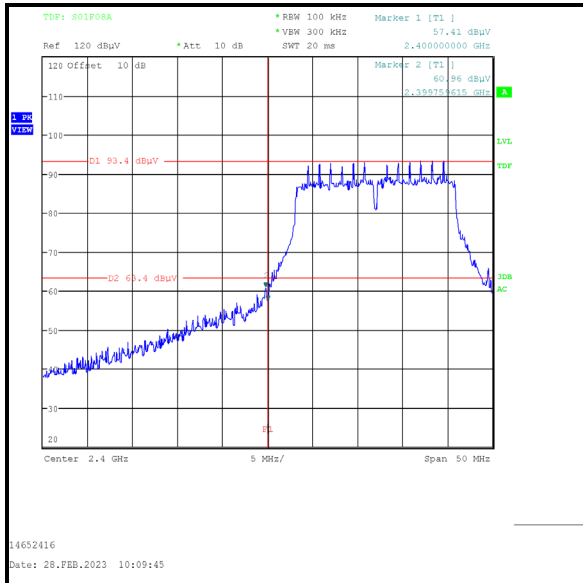
Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2390.000	Horizontal	65.8	74.0	8.2	Complied

Results: 2310 MHz to 2390 MHz Restricted Band / Average

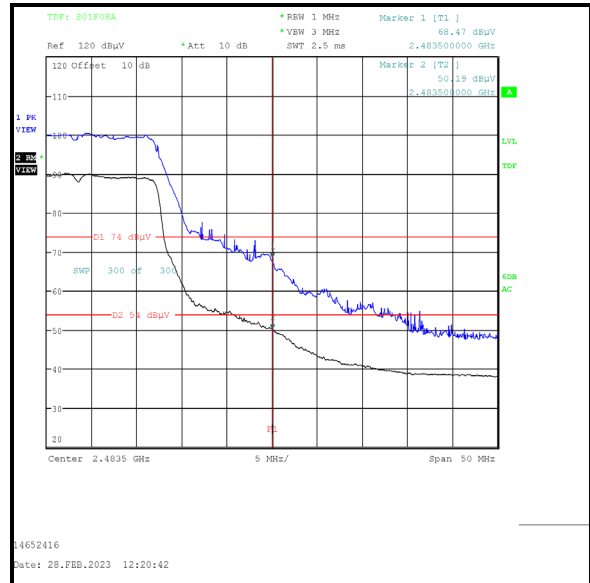
Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Duty cycle correction (dB)	Corrected Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2390.000	Horizontal	47.0	3.3	50.3	54.0	3.7	Complied

Transmitter Band Edge Radiated Emissions (continued)

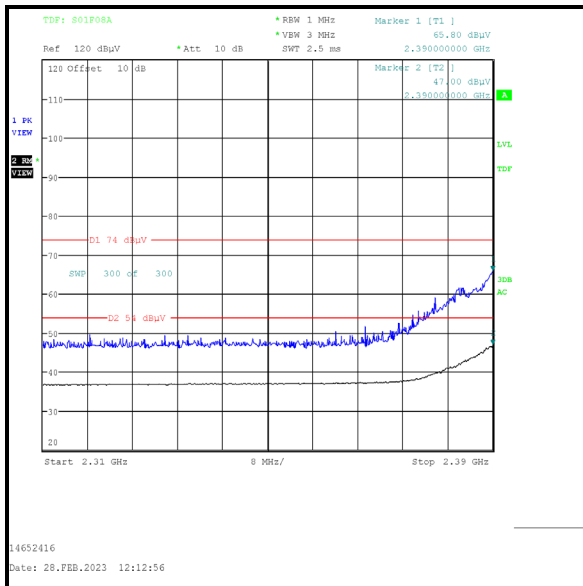
Results: 802.11n HT20 / 20 MHz / MCS0



Lower Band Edge



Upper Band Edge



2310 MHz to 2390 MHz Restricted Band

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