



# TEST REPORT

**Test Report No. :** UL-RPT-RP13559945JD07A V3.0

**Customer** : Apple Inc.

**Model No. / HVIN** : A2520

**PMN** : Apple Magic Keyboard with Touch ID and Numeric Keypad

**FCC ID** : BCGA2520

**ISED Certification No.** : IC: 579C-A2520


**Technology** : *Bluetooth* – BDR & EDR


**Test Standard(s)** : FCC Parts 15.207, 15.247(a)(1), 15.247(a)(1)(iii), 15.247(b)(1) & 15.247(d)  
Innovation, Science and Economic Development Canada  
RSS-247 Issue 2 Sections 5.1(a), 5.1(b), 5.1(d), 5.4(b) & 5.5  
RSS-Gen Issue 5 Sections 6.7, 6.12 & 8.8

**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 3.0 supersedes all previous versions.

**Date of Issue:** 07 April 2021

**Checked by:**   
Sarah Williams  
RF Operations Leader, Radio Laboratory

**Company Signatory:**   
Ben Mercer  
Lead Project Engineer, Radio Laboratory



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**Customer Information**

<b>Company Name:</b>	Apple Inc.
<b>Address:</b>	One Apple Park Way Cupertino, California 95014 U.S.A.
<b>Contact Name:</b>	Stuart Thomas

**Report Revision History**

<b>Version Number</b>	<b>Issue Date</b>	<b>Revision Details</b>	<b>Revised By</b>
1.0	17/03/2021	Initial Version	Sarah Williams
2.0	01/04/2021	PMN update, AC Conducted & <30 MHz tests added	Sarah Williams
3.0	07/04/2021	FCC ID update	Sarah Williams

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## **1. Attestation of Test Results**

### **1.1. Description of EUT**

The equipment under test was a *Bluetooth* Keyboard.

### **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>	47CFR15.207 & 47CFR15.209
<b>Specification Title:</b>	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) - Sections 15.207 & 15.209
<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>FCC Lab. Designation No.:</b>	UK2011
<b>ISEDC CABID:</b>	UK0001
<b>Location of Testing:</b>	Unit 3 Horizon, Wade Road, Kingsland Business Park, Basingstoke, Hampshire, RG24 8AH, United Kingdom
<b>Test Dates:</b>	09 December 2020 to 30 March 2021

### **1.3. Summary of Test Results**

<b>FCC Reference (47CFR)</b>	<b>ISED Canada Reference</b>	<b>Measurement</b>	<b>Result</b>
N/A	RSS-Gen 6.7	99% Emission Bandwidth	Complied
Part 15.247(a)(1)	RSS-Gen 6.7 / RSS-247 5.1(a)	Transmitter 20 dB Bandwidth	Complied
Part 15.247(a)(1)	RSS-247 5.1(b)	Transmitter Carrier Frequency Separation	Complied
Part 15.247(a)(1)(iii)	RSS-247 5.1(d)	Transmitter Number of Hopping Frequencies and Average Time of Occupancy	Complied
Part 15.247(b)(1)	RSS-Gen 6.12 / RSS-247 5.4(b)	Transmitter Maximum Peak Output Power	Complied
Part 15.247(d) & 15.209(a)	RSS-Gen 6.13 / RSS-247 5.5	Transmitter Radiated Emissions	Complied
Part 15.247(d) & 15.209(a)	RSS-Gen 6.13 / RSS-247 5.5	Transmitter Band Edge Radiated Emissions	Complied
Part 15.207	RSS-Gen 8.8	Transmitter AC Conducted Emissions	Complied

**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	-

UL International (UK) Ltd is accredited by the United Kingdom Accreditation Service (UKAS). UKAS is one of the signatories to the International Laboratory Accreditation Co-operation (ILAC) Arrangement for the mutual recognition of test reports. 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
<b>Reference:</b>	KDB 174176 D01 Line Conducted FAQ v01r01 June 3, 2015
<b>Title:</b>	AC Power-Line Conducted Emissions Frequently Asked Questions

## **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**

#### **Overview**

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 of the measurand (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.

#### **Decision Rule**

The decision rule applied is based upon the accuracy method criteria. The measurement uncertainty is met and the result is considered in conformance with the requirement criteria if the observed value is within the prescribed limit.

#### **Measurement Uncertainty**

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
99% Emission Bandwidth	2.4 GHz to 2.4835 GHz	95%	±3.92 %
20 dB Bandwidth	2.4 GHz to 2.4835 GHz	95%	±4.59 %
Carrier Frequency Separation	2.4 GHz to 2.4835 GHz	95%	±4.59 %
Average Time of Occupancy	2.4 GHz to 2.4835 GHz	95%	±3.53 ns
Conducted Maximum Peak 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 26.5 GHz	95%	±2.94 dB
AC Conducted Spurious Emissions	0.15 MHz to 30 MHz	95%	±1.96 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

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2002	Thermohygrometer	Testo	608-H1	45041825	05 Jan 2021	12
A3118	Attenuator	AtlanTecRF	AN18-10	237378#2	Calibrated before use	-
M1996	Signal Analyser	Rohde & Schwarz	FSV13	100975	24 Jan 2021	12
G0628	Vector Signal Generator	Rohde & Schwarz	SMBV100A	261847	08 Oct 2023	36

### Test Equipment Used for Transmitter Radiated Emissions

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2040	Thermohygrometer	Testo	608-H1	45124934	10 Dec 2021	12
K0001	3m RSE Chamber	Rainford EMC	N/A	N/A	14 Oct 2021	12
M2044	Test Receiver	Rohde & Schwarz	ESU26	100122	03 Sep 2021	12
M1874	Test Receiver	Rohde & Schwarz	ESU26	100553	24 Apr 2021	12
A3154	Pre-Amplifier	Com Power	PAM-103	18020012	29 Sep 2021	12
A3179	Pre-Amplifier	Hewlett Packard	8449B	3008A00934	29 Sep 2021	12
A3141	Pre-Amplifier	Schwarzbeck	BBV 9718 B	00021	29 Sep 2021	12
A2896	Pre-Amplifier	Schwarzbeck	BBV 9721	9721 - 023	13 Feb 2021	12
A553	Antenna	Chase	CBL6111A	1593	15 Sep 2021	12
A3138	Antenna	Schwarzbeck	BBHA 9120 B	00702	06 Oct 2021	12
A3139	Antenna	Schwarzbeck	HWRD750	00027	06 Oct 2021	12
A2895	Antenna	Schwarzbeck	BBHA 9170	9170-728	13 Feb 2021	12
A3112	Attenuator	AtlanTecRF	AN18-06	219706#2	15 Sep 2021	12
A2141	Attenuator	AtlanTecRF	AN18-10	090918-04	18 Nov 2021	12
A3083	Low Pass Filter	AtlanTecRF	AFL-01000	18010900076	20 Feb 2021	12
A3093	High Pass Filter	AtlanTecRF	AFH-03000	18051800077	20 Feb 2021	12
A3095	High Pass Filter	AtlanTecRF	AFH-07000	18051600012	20 Mar 2021	12
A3198	Magnetic Loop Antenna	ETS-Lindgren	6502	00221887	01 Apr 2021	12



**Test and Measurement Equipment (continued)****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	07 Jan 2021	12
K0001	3m RSE Chamber	Rainford EMC	N/A	N/A	14 Oct 2021	12
M2044	Test Receiver	Rohde & Schwarz	ESU26	100122	03 Sep 2021	12
A3179	Pre-Amplifier	Hewlett Packard	8449B	3008A00934	29 Sep 2021	12
A3138	Antenna	Schwarzbeck	BBHA 9120 B	00702	06 Oct 2021	12
A2523	Attenuator	AtlanTecRF	AN18W5-10	832827#1	21 Feb 2021	12

**Test Equipment Used for Transmitter AC Conducted Spurious Emissions:**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2037	Thermohygrometer	Testo	608-H1	45124925	09 Dec 2021	12
A649	LISN	Rohde & Schwarz	ESH3-Z5	825562/008	03 Aug 2021	12
M1273	Test Receiver	Rohde & Schwarz	ESIB 26	100275	14 Dec 2021	12
A1830	Pulse Limiter	Rohde & Schwarz	ESH3-Z2	100668	07 Apr 2021	12

**Test Measurement Software/Firmware Used:**

Name	Version	Release Date
Rohde & Schwarz EMC32	6.30.0	2018

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

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

<b>Brand Name:</b>	Apple
<b>Model Name or Number / HVIN:</b>	A2520
<b>PMN:</b>	Apple Magic Keyboard with Touch ID and Numeric Keypad
<b>Test Sample Serial Number:</b>	F0T0483001A0VX90M <i>(Conducted sample)</i>
<b>Hardware Version:</b>	REV 1.0
<b>Software Version:</b>	0xF125
<b>FCC ID:</b>	BCGA2520
<b>ISED Canada Certification Number:</b>	IC: 579C-A2520

<b>Brand Name:</b>	Apple
<b>Model Name or Number / HVIN:</b>	A2520
<b>PMN:</b>	Apple Magic Keyboard with Touch ID and Numeric Keypad
<b>Test Sample Serial Number:</b>	F0T047300000VX903 <i>(Radiated sample #1)</i>
<b>Hardware Version:</b>	REV 1.0
<b>Software Version:</b>	0xF125
<b>FCC ID:</b>	BCGA2520
<b>ISED Canada Certification Number:</b>	IC: 579C-A2520

<b>Brand Name:</b>	Apple
<b>Model Name or Number / HVIN:</b>	A2520
<b>PMN:</b>	Apple Magic Keyboard with Touch ID and Numeric Keypad
<b>Test Sample Serial Number:</b>	F0T0473000L0VX90H <i>(Radiated sample #2)</i>
<b>Hardware Version:</b>	REV 1.0
<b>Software Version:</b>	0xF125
<b>FCC ID:</b>	BCGA2520
<b>ISED Canada Certification Number:</b>	IC: 579C-A2520

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

No modifications were applied to the EUT during testing.

### 3.3. Additional Information Related to Testing

Tested Technology:	Bluetooth			
Power Supply Requirement:	Nominal	3.8 VDC		
Type of Unit:	Transceiver			
Channel Spacing:	1 MHz			
Mode:	Basic Rate	Enhanced Data Rate		
Modulation:	GFSK	π/4-DQPSK	8DPSK	8DPSK
Packet Type: (Maximum Payload)	DH1	2DH1	3DH1	3DH5
Data Rate (Mbps):	1	2	3	3
Maximum Conducted Output Power:	6.4 dBm			
Transmit Frequency Range:	2402 MHz to 2480 MHz			
Transmit Channels Tested:	Channel ID	Channel Number	Channel Frequency (MHz)	
	Bottom	0	2402	
	Middle	39	2441	
	Top	78	2480	

### 3.4. Description of Available Antennas

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

Frequency Range (MHz)	Antenna Gain (dBi)
2402	3.5
2441	4.3
2480	3.6

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

#### **Support Equipment**

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

<b>Description:</b>	Test Laptop
<b>Brand Name:</b>	Apple
<b>Model Name or Number:</b>	MacBook Pro
<b>Serial Number:</b>	C02C800KP0CW

<b>Description:</b>	USB Diagnostic Cable
<b>Brand Name:</b>	Apple
<b>Model Name or Number:</b>	Kanzi
<b>Serial Number:</b>	3252E1

<b>Description:</b>	USB Adaptor Type C-A
<b>Brand Name:</b>	Apple
<b>Model Name or Number:</b>	A1632
<b>Serial Number:</b>	Not marked or stated

<b>Description:</b>	USB to Lightning Cable
<b>Brand Name:</b>	Apple
<b>Model Name or Number:</b>	A1480
<b>Serial Number:</b>	Not marked or stated

<b>Description:</b>	USB Power Supply
<b>Brand Name:</b>	Apple
<b>Model Name or Number:</b>	A3185
<b>Serial Number:</b>	D293092Z6E9DHLHCH

<b>Description:</b>	Test Laptop
<b>Brand Name:</b>	Apple
<b>Model Name or Number:</b>	MacBook Pro
<b>Serial Number:</b>	C02WP003JW64

**Operating Modes**

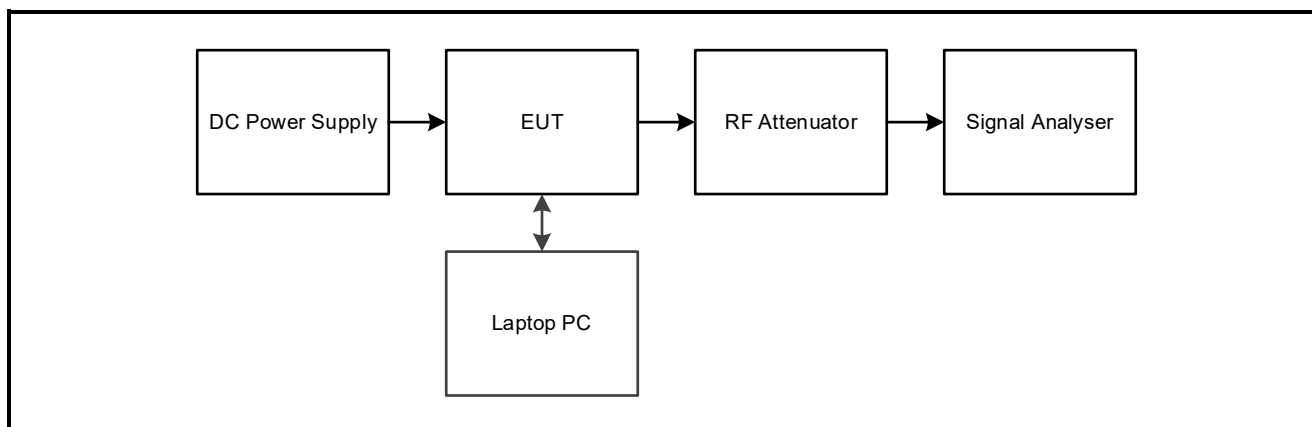
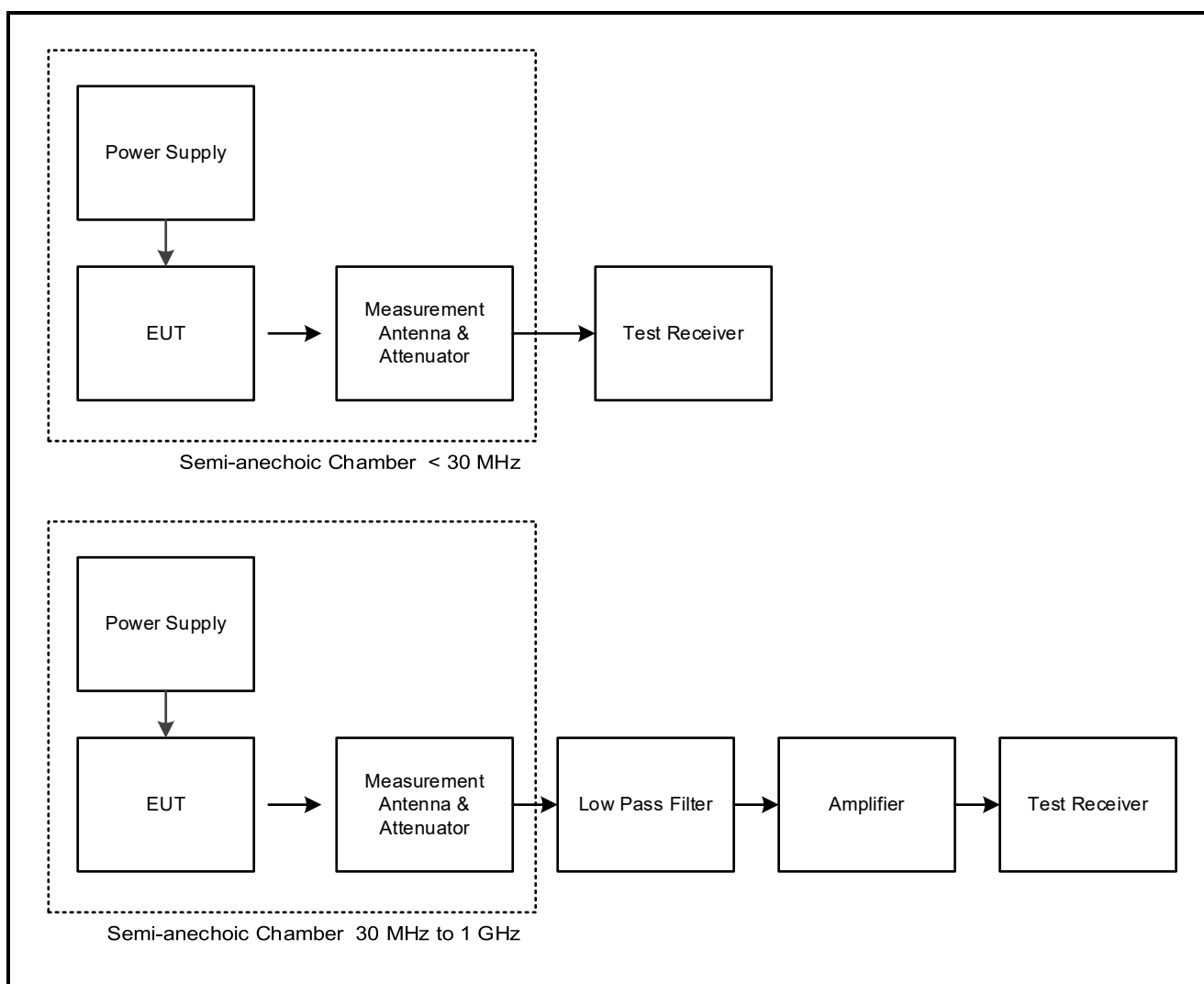
The EUT was tested in the following operating mode(s):

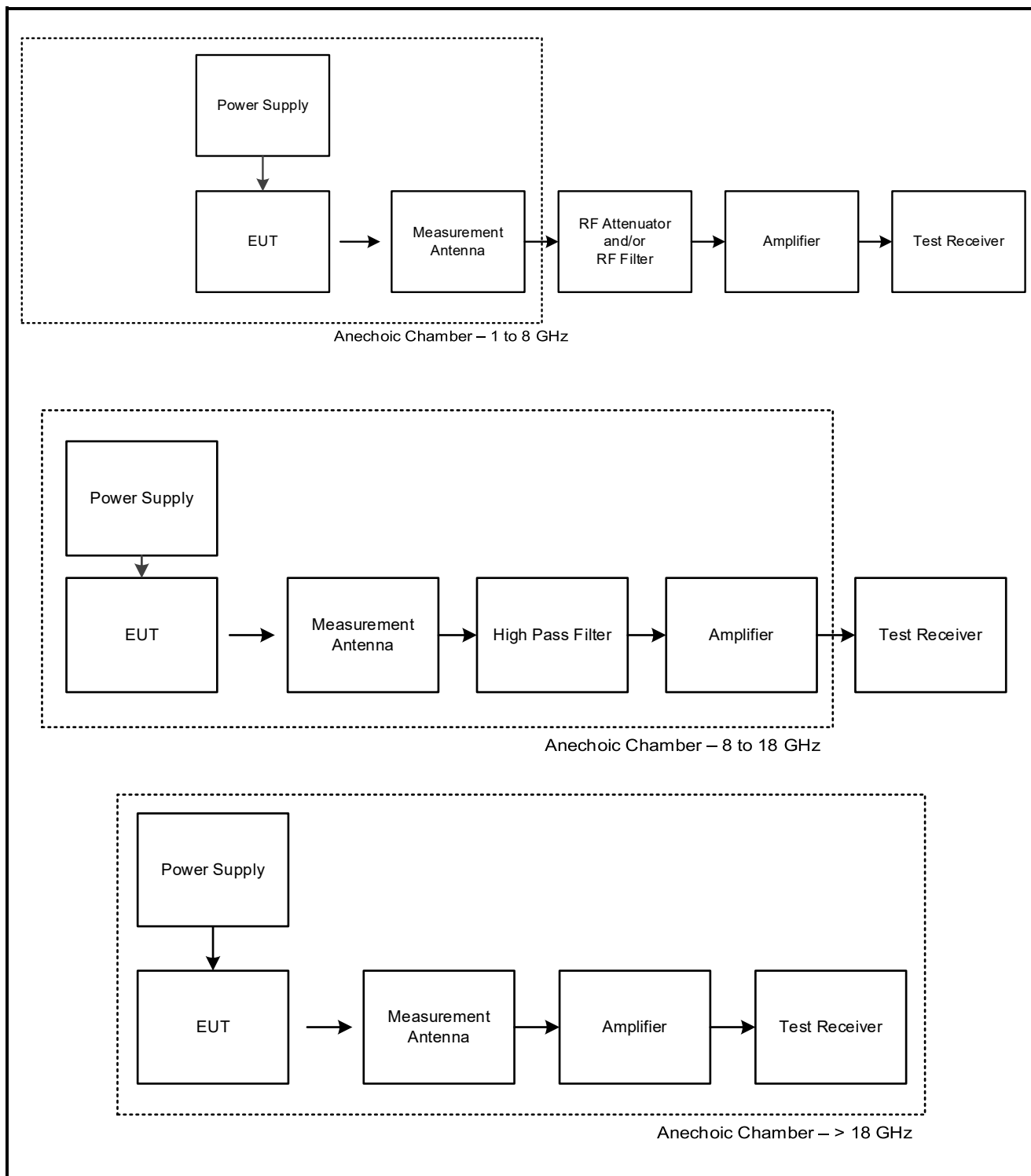
- Continuously transmitting at maximum power on bottom, middle and top channels in BDR (DH1 packets) or EDR (2DH1, 3DH1 or 3DH5 packets) as required.
- Continuously transmitting at maximum power in hopping mode on all channels in BDR (DH1 packets) or EDR (2DH1, 3DH1 or 3DH5 packets) as required.

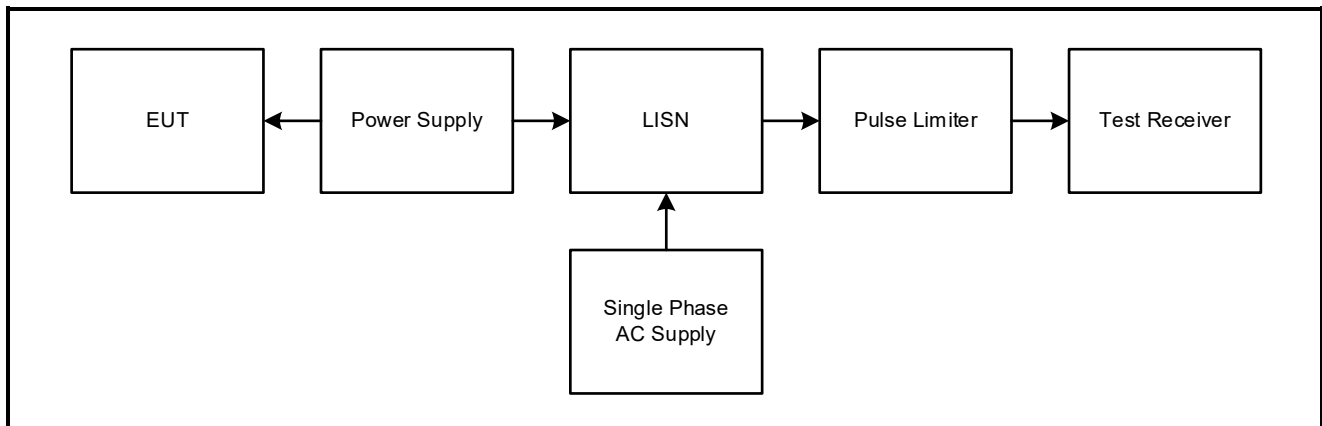
**Configuration and Peripherals**

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

- Controlled in test mode using a set of commands entered into a terminal application on the test laptop supplied by the customer. The commands were used to enable a continuous transmission and to select the test channels as required. The customer supplied a document containing the setup instructions 'EUT\_BT\_SOP.docx'.
- The EUT was powered from a DC power supply for conducted test.
- For transmitter radiated spurious emissions tests, initial checks were performed with the EUT transmitting in all available data rates. EDR (2-DH1 packets) mode was found to transmit the highest power and was therefore deemed worst case.
- Transmitter radiated spurious emissions tests were performed with the AC Charger connected to the EUT.

**Test Setup Diagrams****Conducted Tests:****Test Setup for Transmitter Conducted Tests****Radiated Tests:****Test Setup for Transmitter Radiated Emissions**

**Test Setup Diagrams (continued)****Test Setup for Transmitter Radiated Emissions (continued)**

**Test Setup Diagrams (continued)****Test Setup for Transmitter AC Conducted Emissions**



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

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

#### **Test Summary:**

<b>Test Engineers:</b>	Chanthu Thevarajah & Matthew Botfield	<b>Test Date:</b>	10 December 2020
<b>Test Sample Serial Number:</b>	F0T0483001A0VX90M		

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

#### **Environmental Conditions:**

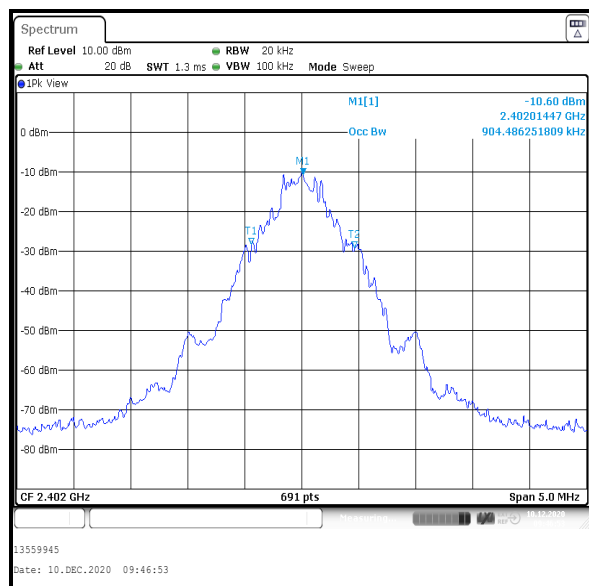
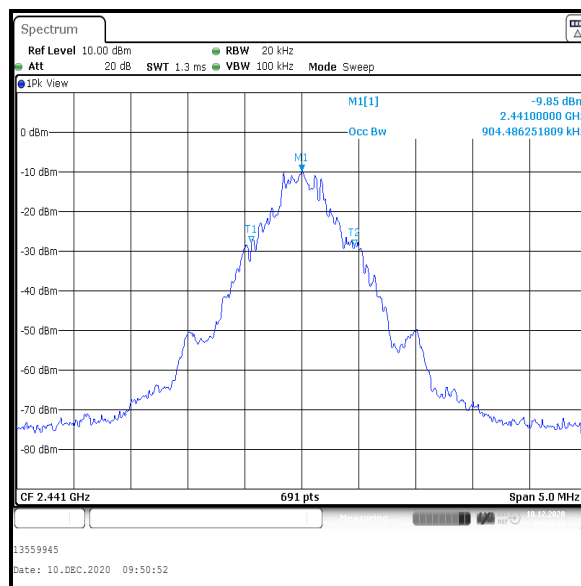
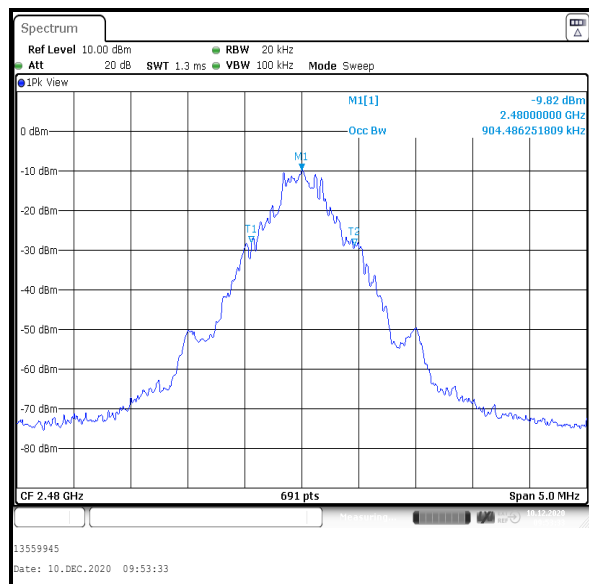
<b>Temperature (°C):</b>	22
<b>Relative Humidity (%):</b>	38

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

1. The signal analyser resolution bandwidth was set to 20 kHz and video bandwidth 100 kHz. A peak detector was used, sweep time was set to auto and the trace mode was Max Hold. The span was set to 5 MHz. The signal analyser occupied bandwidth function measured the 99% emission bandwidth.
2. The signal analyser was connected to the RF port on the EUT using suitable attenuation and RF cable.

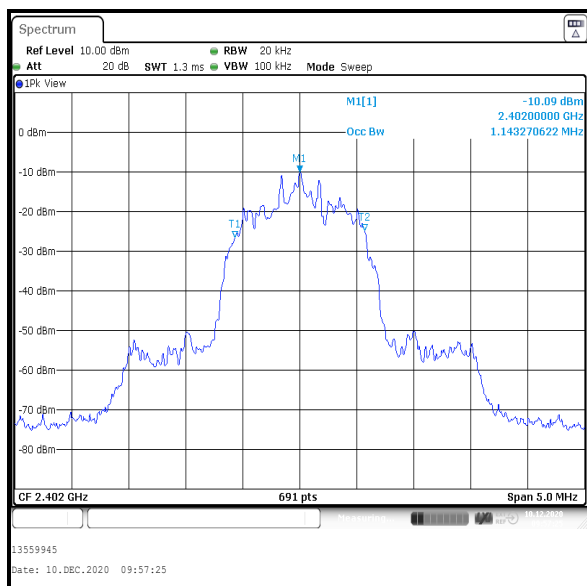
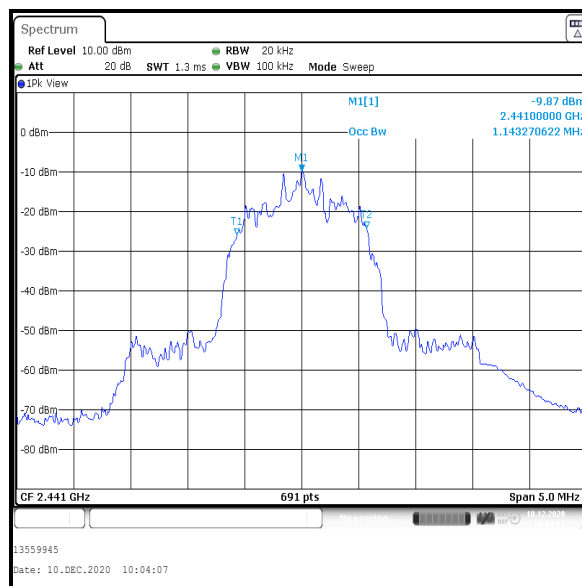
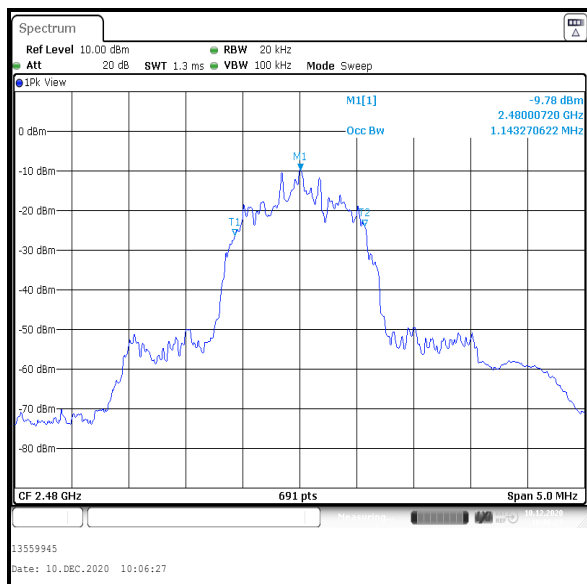
**Transmitter 99% Emission Bandwidth (continued)****Results: DH1**

Channel	99% Emission Bandwidth (kHz)
Bottom	904.486
Middle	904.486
Top	904.486

**Bottom Channel****Middle Channel****Top Channel**

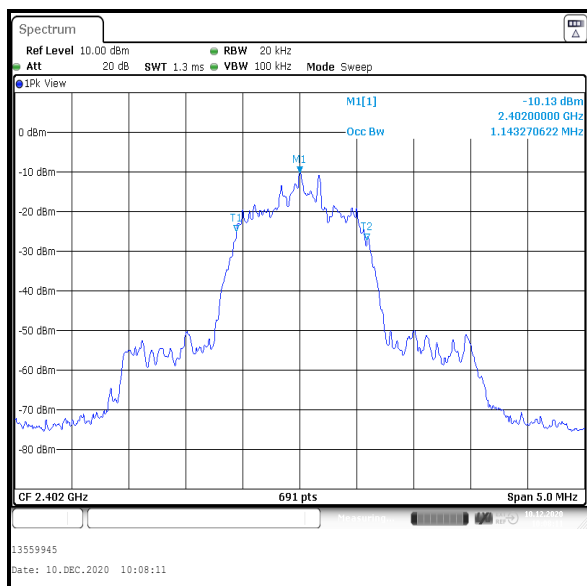
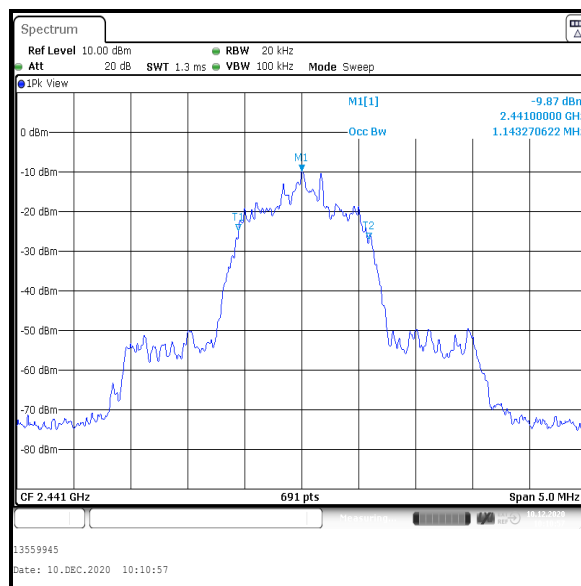
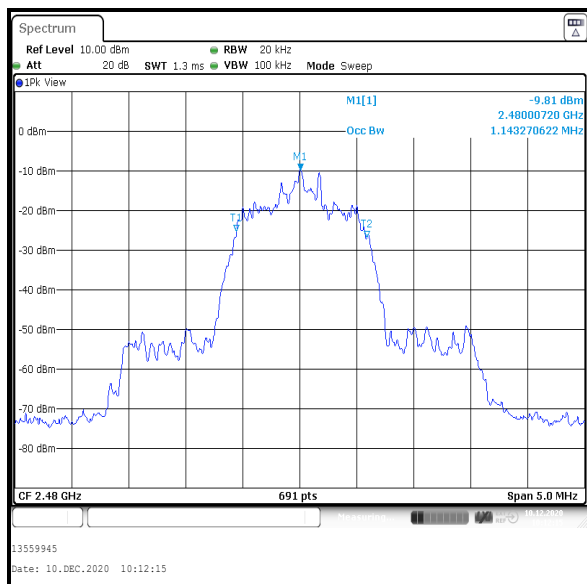
**Transmitter 99% Emission Bandwidth (continued)****Results: 2DH1**

Channel	99% Emission Bandwidth (kHz)
Bottom	1143.271
Middle	1143.271
Top	1143.271

**Bottom Channel****Middle Channel****Top Channel**

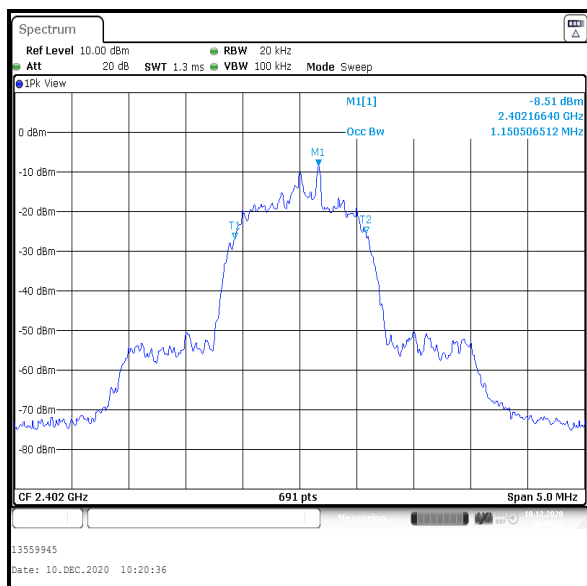
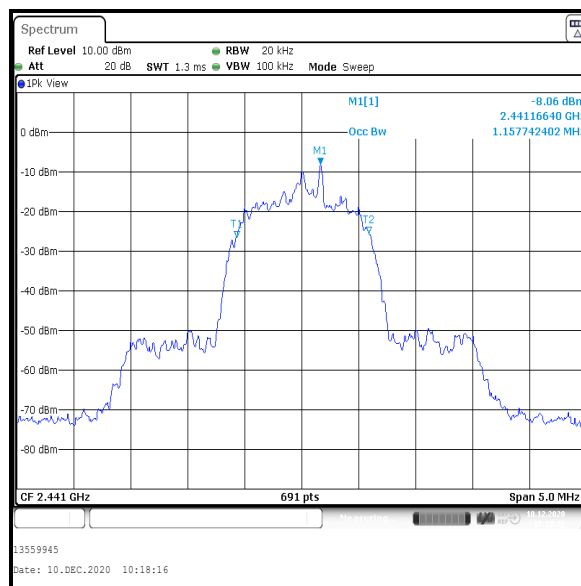
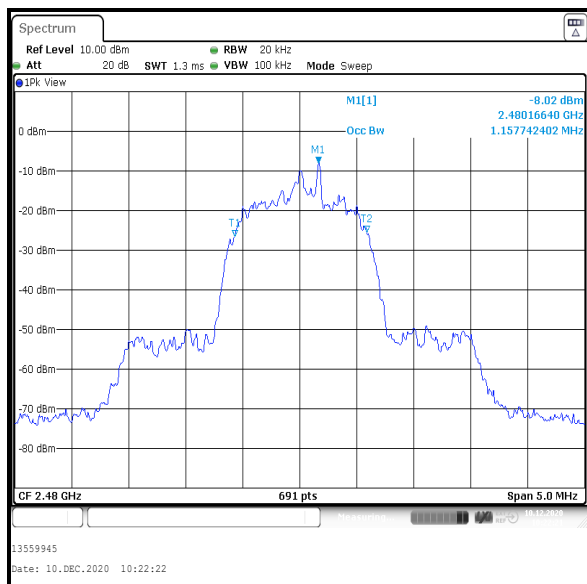
**Transmitter 99% Emission Bandwidth (continued)****Results: 3DH1**

Channel	99% Emission Bandwidth (kHz)
Bottom	1143.271
Middle	1143.271
Top	1143.271

**Bottom Channel****Middle Channel****Top Channel**

**Transmitter 99% Emission Bandwidth (continued)****Results: 3DH5**

Channel	99% Emission Bandwidth (kHz)
Bottom	1150.507
Middle	1157.742
Top	1157.742

**Bottom Channel****Middle Channel****Top Channel**

## **4.2. Transmitter 20 dB Bandwidth**

### **Test Summary:**

<b>Test Engineers:</b>	Chanthu Thevarajah & Matthew Botfield	<b>Test Dates:</b>	09 December 2020 & 10 December 2020
<b>Test Sample Serial Number:</b>	F0T0483001A0VX90M		

<b>FCC Reference:</b>	Part 15.247(a)(1)
<b>ISED Canada Reference:</b>	RSS-Gen 6.7 / RSS-247 5.1(a)
<b>Test Method Used:</b>	ANSI C63.10 Section 6.9.2

### **Environmental Conditions:**

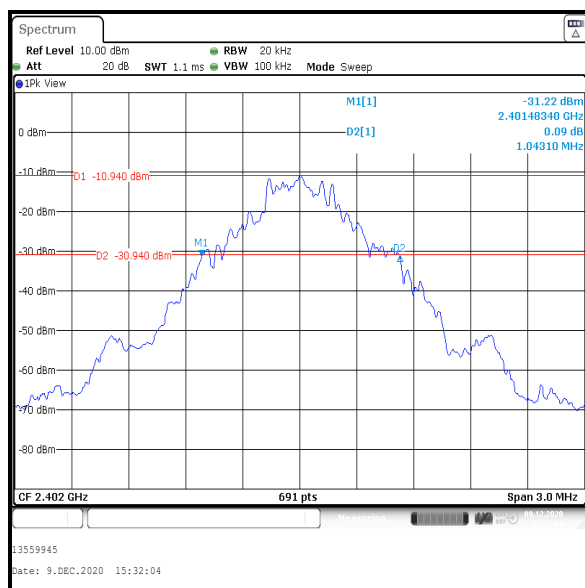
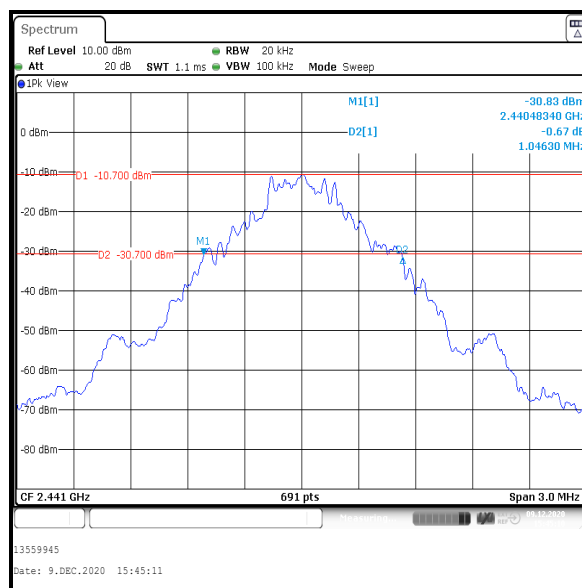
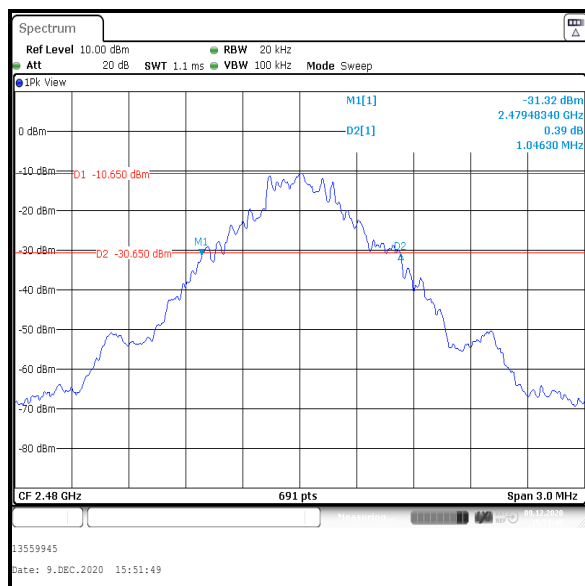
<b>Temperature (°C):</b>	22
<b>Relative Humidity (%):</b>	33 to 38

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

1. The signal analyser resolution bandwidth was set to 20 kHz and video bandwidth 100 kHz. A peak detector was used, sweep time was set to auto and the trace mode was Max Hold. The span was set to 3 MHz. Normal and delta markers were placed 20 dB down from the peak of the carrier.
2. The signal analyser was connected to the RF port on the EUT using suitable attenuation and RF cable.

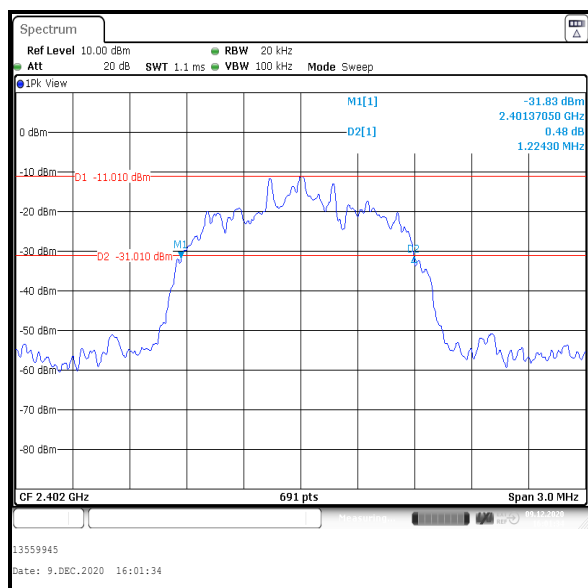
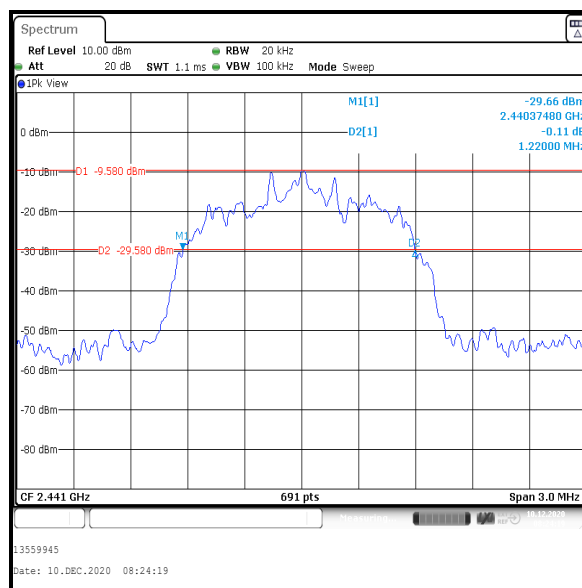
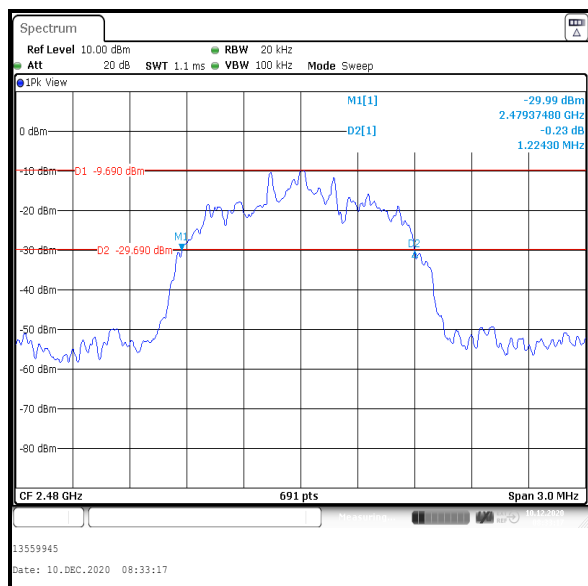
**Transmitter 20 dB Bandwidth (continued)****Results: DH1**

Channel	20 dB Bandwidth (kHz)
Bottom	1043.100
Middle	1046.300
Top	1046.300

**Bottom Channel****Middle Channel****Top Channel**

**Transmitter 20 dB Bandwidth (continued)****Results: 2DH1**

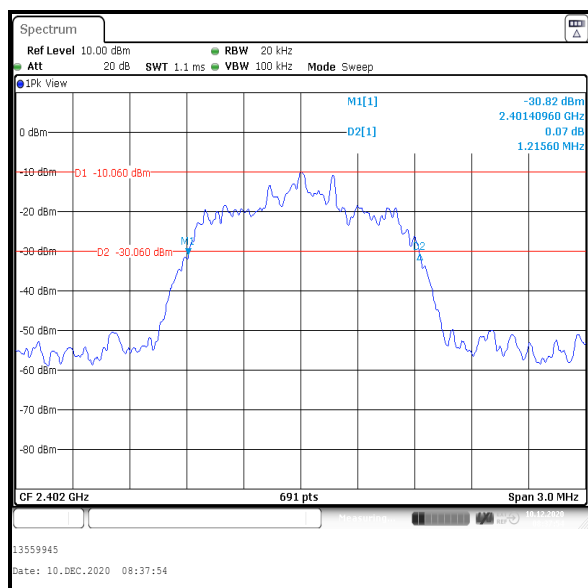
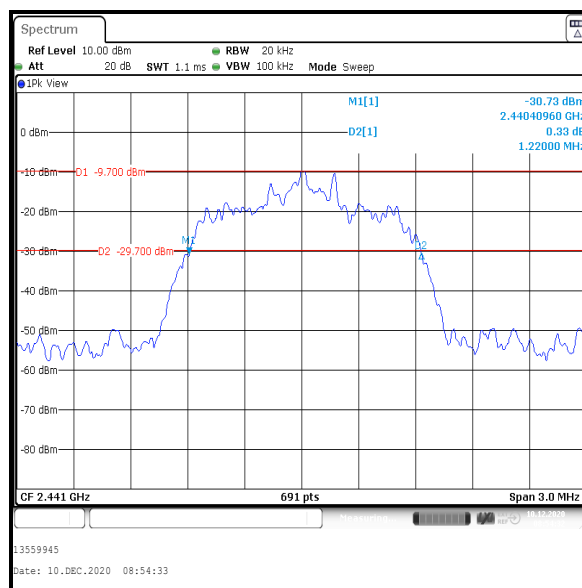
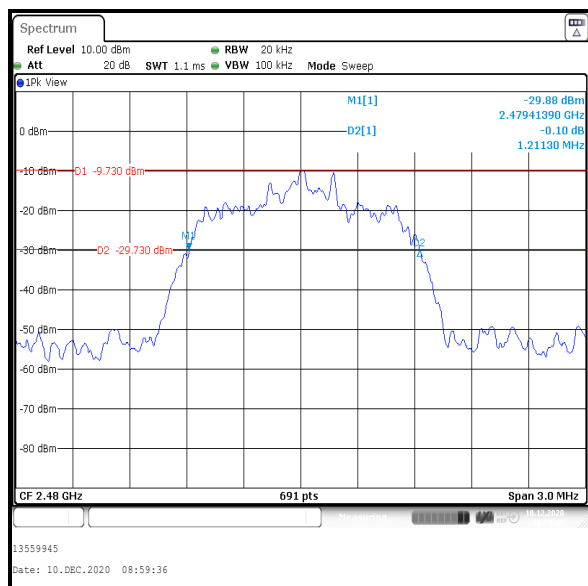
Channel	20 dB Bandwidth (kHz)
Bottom	1224.300
Middle	1220.000
Top	1224.300

**Bottom Channel****Middle Channel****Top Channel**



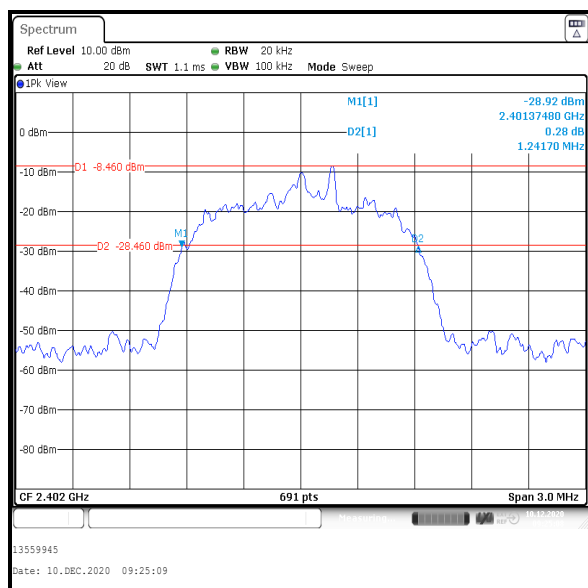
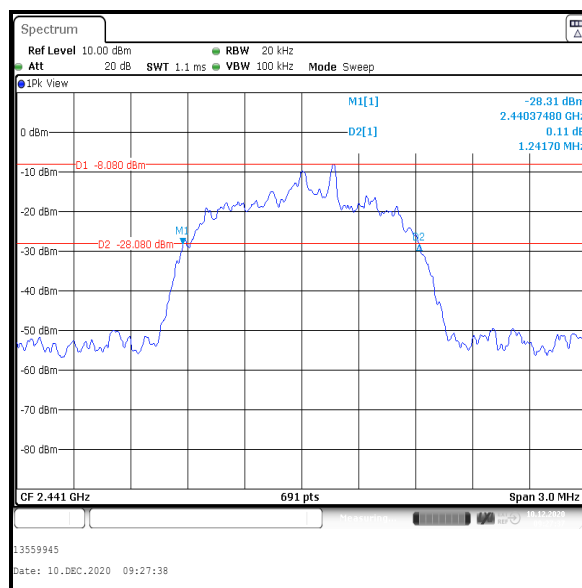
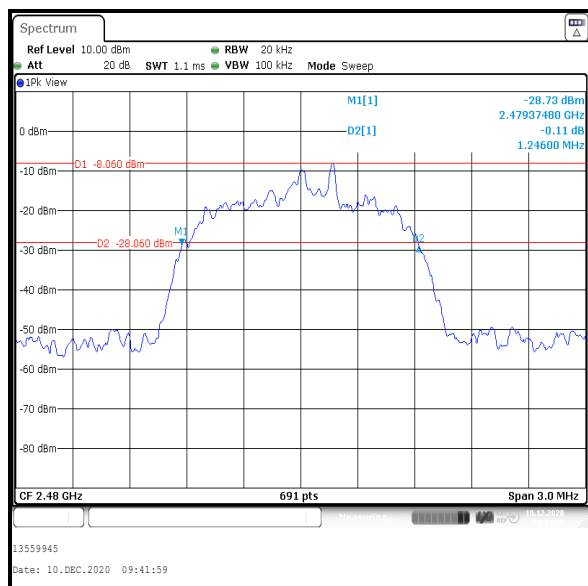
**Transmitter 20 dB Bandwidth (continued)****Results: 3DH1**

Channel	20 dB Bandwidth (kHz)
Bottom	1215.600
Middle	1220.000
Top	1211.300

**Bottom Channel****Middle Channel****Top Channel**

**Transmitter 20 dB Bandwidth (continued)****Results: 3DH5**

Channel	20 dB Bandwidth (kHz)
Bottom	1241.700
Middle	1241.700
Top	1246.000

**Bottom Channel****Middle Channel****Top Channel**

### **4.3. Transmitter Carrier Frequency Separation**

#### **Test Summary:**

<b>Test Engineers:</b>	Chanthu Thevarajah & Matthew Botfield	<b>Test Date:</b>	10 December 2020
<b>Test Sample Serial Number:</b>	F0T0483001A0VX90M		

<b>FCC Reference:</b>	Part 15.247(a)(1)
<b>ISED Canada Reference:</b>	RSS-247 5.1(b)
<b>Test Method Used:</b>	ANSI C63.10 Section 7.8.2

#### **Environmental Conditions:**

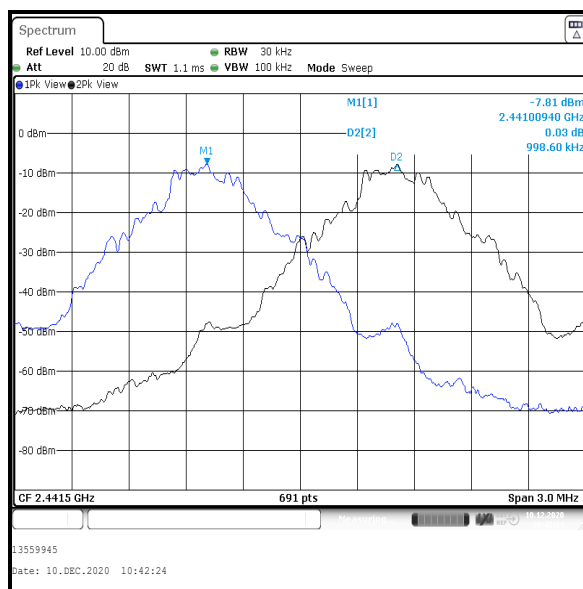
<b>Temperature (°C):</b>	22
<b>Relative Humidity (%):</b>	38

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

1. The 20 dB bandwidth measured for the middle channel operating at 2441 MHz was used to calculate the limit.
2. The signal analyser resolution bandwidth was set to 30 kHz and video bandwidth 100 kHz. A peak detector was used, sweep time was set to auto and trace mode was Max Hold. The span was set to 3 MHz. A marker was placed at the centre of one signal and then a delta marker was placed in the same place on the second signal.
3. The signal analyser was connected to the RF port on the EUT using suitable attenuation and RF cable.

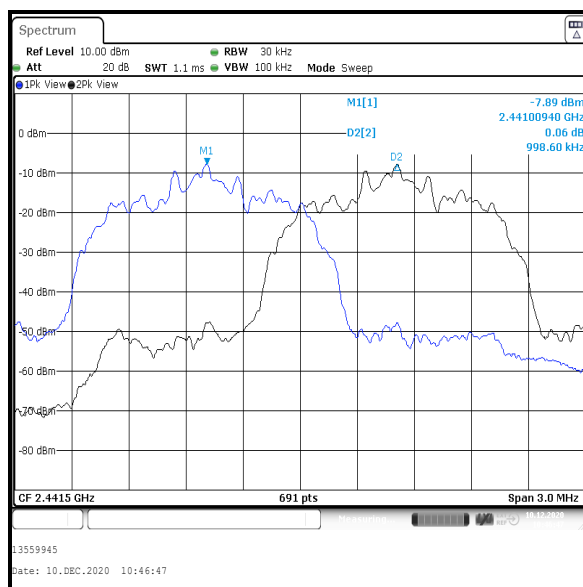
**Transmitter Carrier Frequency Separation (continued)****Results: DH1**

Carrier Frequency Separation (kHz)	Limit ( $2/3$ of 20 dB BW) (kHz)	Margin (kHz)	Result
998.600	697.533	301.067	Complied



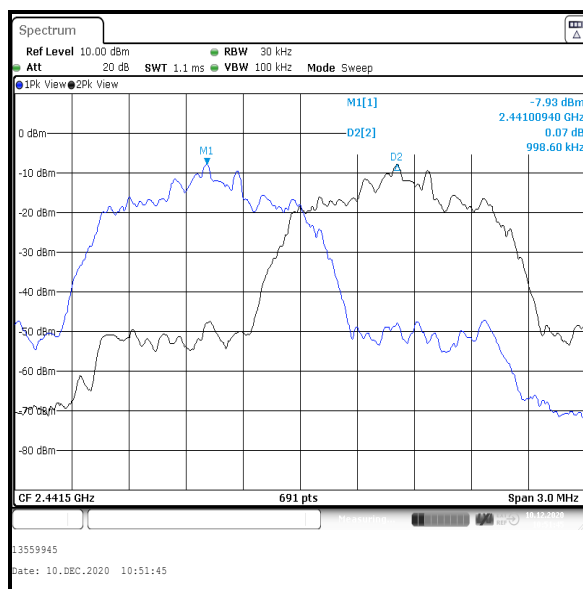
**Transmitter Carrier Frequency Separation (continued)****Results: 2DH1**

Carrier Frequency Separation (kHz)	Limit ( $2/3$ of 20 dB BW) (kHz)	Margin (kHz)	Result
998.600	813.333	185.267	Complied



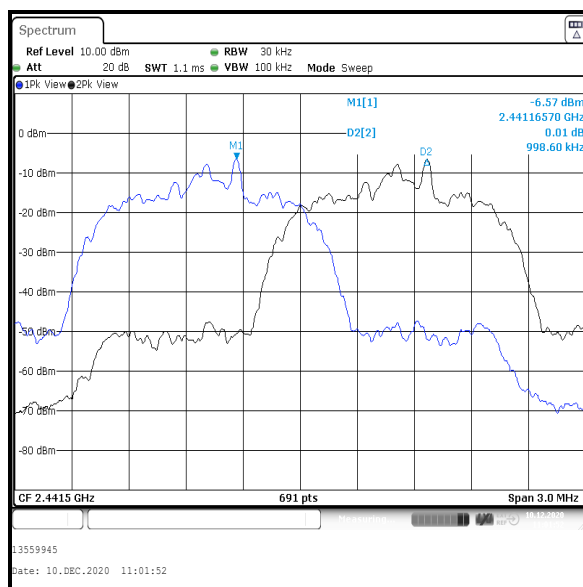
**Transmitter Carrier Frequency Separation (continued)****Results: 3DH1**

Carrier Frequency Separation (kHz)	Limit ( $2/3$ of 20 dB BW) (kHz)	Margin (kHz)	Result
998.600	813.333	185.267	Complied



**Transmitter Carrier Frequency Separation (continued)****Results: 3DH5**

Carrier Frequency Separation (kHz)	Limit ( $2/3$ of 20 dB BW) (kHz)	Margin (kHz)	Result
998.600	827.800	170.800	Complied



**4.4. Transmitter Number of Hopping Frequencies and Average Time of Occupancy****Test Summary:**

<b>Test Engineers:</b>	Chanthu Thevarajah & Matthew Botfield	<b>Test Date:</b>	10 December 2020
<b>Test Sample Serial Number:</b>	F0T0483001A0VX90M		

<b>FCC Reference:</b>	Part 15.247(a)(1)(iii)
<b>ISED Canada Reference:</b>	RSS-247 5.1(d)
<b>Test Method Used:</b>	ANSI C63.10 Sections 7.8.3 & 7.8.4

**Environmental Conditions:**

<b>Temperature (°C):</b>	22
<b>Relative Humidity (%):</b>	38

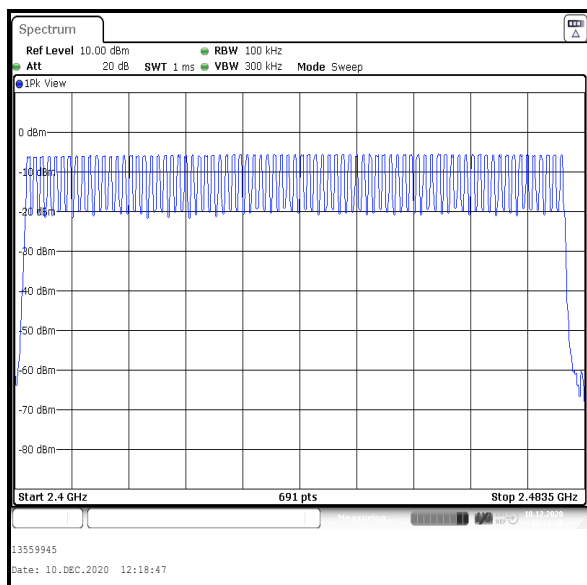
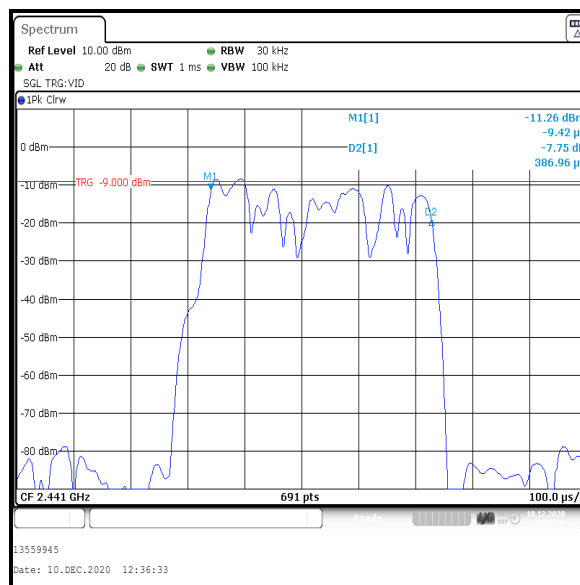
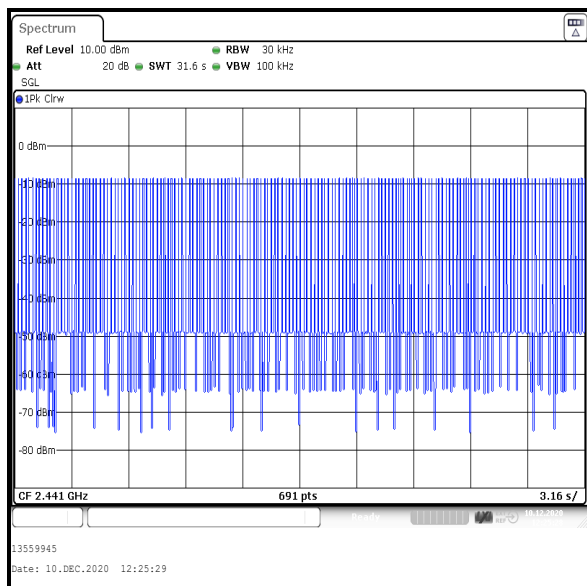
**Note(s):**

1. Tests were performed to identify the average time of occupancy in number of channels (79) x 0.4 seconds. The calculated period is 31.6 seconds.
2. The signal analyser was set up for the Number of Hopping Frequencies measurement as follows: the resolution bandwidth was set to 100 kHz and video bandwidth of 300 kHz. A peak detector was used, sweep time was set to auto and trace mode was Max Hold. The span was set to 83.5 MHz.
3. The signal analyser was set up for the Emission Width measurement as follows: the resolution bandwidth was set to 30 kHz and video bandwidth of 100 kHz. A peak detector was used and sweep time was set to auto with a span of zero Hz. The signal analyser was set to trigger at 0.35 ms for 1-DH1 and 1 ms for 3-DH5, with a marker placed at the start of the emission and a delta marked place at the end of the emission. The emission width is recorded in the table below.
4. The signal analyser was set up for the Number of Hopping Frequencies in 32 seconds measurement as follows: the resolution bandwidth was set to 30 kHz and video bandwidth of 100 kHz. A peak detector was used and sweep time was set to 31.6 seconds. The EUT was set to transmit in a hopping frequency mode with zero span. The total number of hopping frequencies were recorded in the table below.
5. The signal analyser was connected to the RF port on the EUT using suitable attenuation and RF cable.



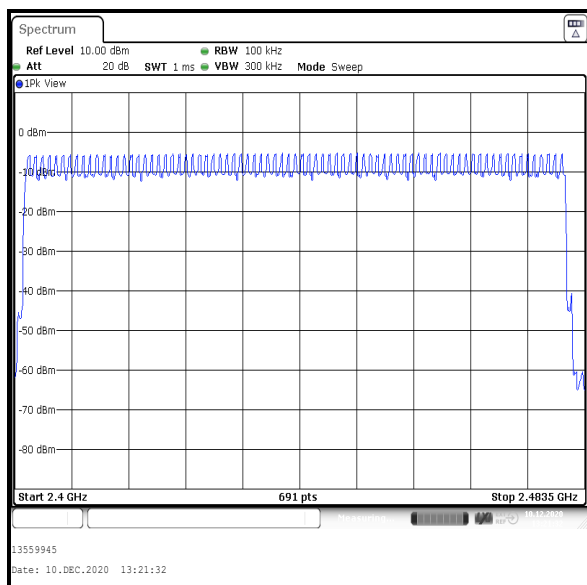
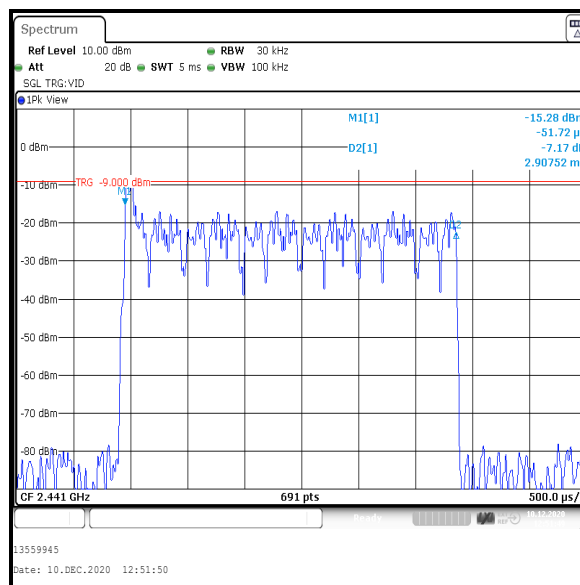
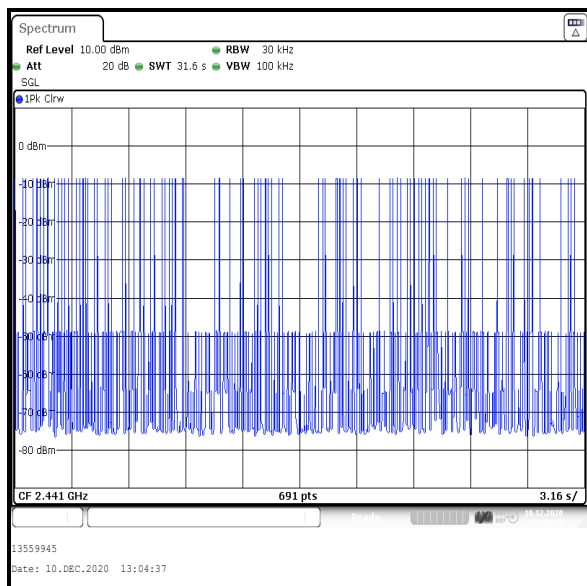
**Transmitter Number of Hopping Frequencies and Average Time of Occupancy (continued)****Results: DH1**

Emission Width ( $\mu$ s)	Number of Hops in 31.6 Seconds	Average Time of Occupancy (s)	Limit (s)	Margin (s)	Result
386.960	168	0.065	0.4	0.335	Complied

**Number of Hopping Frequencies****Emission Width****Number of Hopping Frequencies in 32 s**

**Transmitter Number of Hopping Frequencies and Average Time of Occupancy (continued)****Results: 3DH5**

Emission Width (μs)	Number of Hops in 31.6 Seconds	Average Time of Occupancy (s)	Limit (s)	Margin (s)	Result
2907.520	97	0.282	0.4	0.118	Complied

**Number of Hopping Frequencies****Emission Width****Number of Hopping Frequencies in 32 s**

#### **4.5. Transmitter Maximum Peak Output Power**

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

<b>Test Engineers:</b>	Chanthu Thevarajah & Matthew Botfield	<b>Test Date:</b>	10 December 2020
<b>Test Sample Serial Number:</b>	F0T0483001A0VX90M		

<b>FCC Reference:</b>	Part 15.247(b)(1)
<b>ISED Canada Reference:</b>	RSS-Gen 6.12 / RSS-247 5.4(b)
<b>Test Method Used:</b>	ANSI C63.10 Section 7.8.5

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

<b>Temperature (°C):</b>	22
<b>Relative Humidity (%):</b>	38

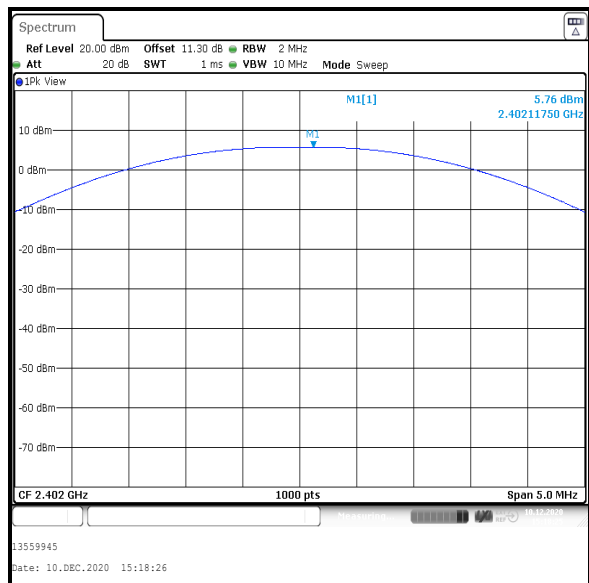
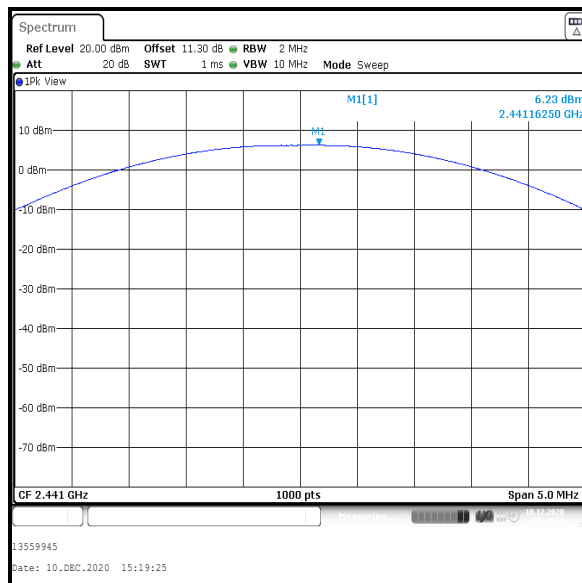
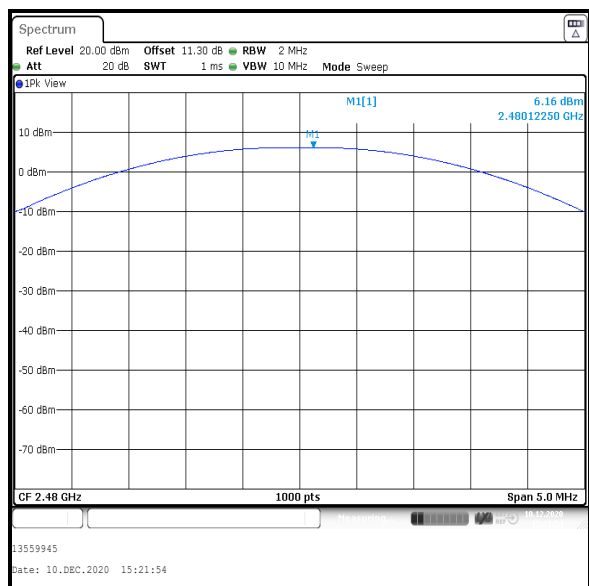
##### **Note(s):**

1. The signal analyser resolution bandwidth was set to 2 MHz (>20 dB bandwidth) and video bandwidth of 10 MHz. A peak detector was used, sweep time was set to auto and trace mode was Max Hold. The span was set to 5 MHz (approximately five times the 20 dB bandwidth). A marker was placed at the peak of the signal and the results recorded in the tables below.
2. The declared antenna gain was added to the conducted peak power to obtain the EIRP.
3. The signal analyser was connected to the RF port on the EUT using suitable attenuation and RF cable. An RF offset level was entered on the signal analyser to compensate for the loss of the attenuator and RF cable.

**Transmitter Maximum Peak Output Power (continued)****Results: DH1**

Channel	Conducted Peak Power (dBm)	Conducted Peak Power Limit (dBm)	Margin (dB)	Result
Bottom	5.8	30.0	24.2	Complied
Middle	6.2	30.0	23.8	Complied
Top	6.2	30.0	23.8	Complied

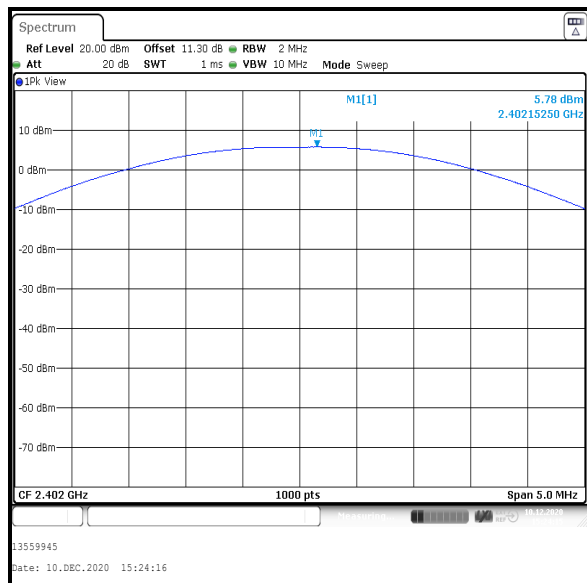
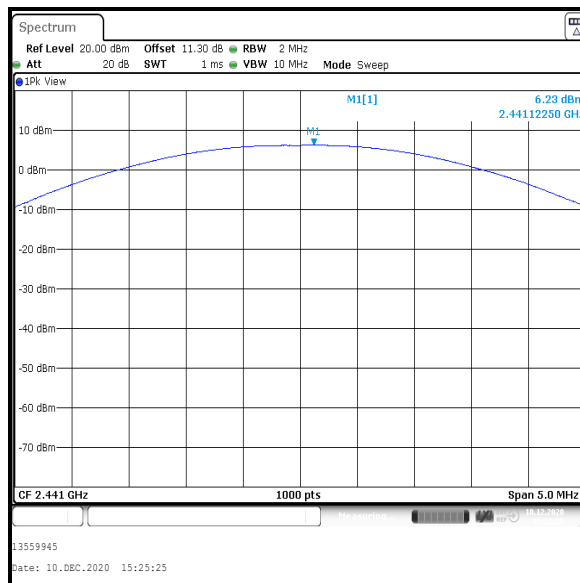
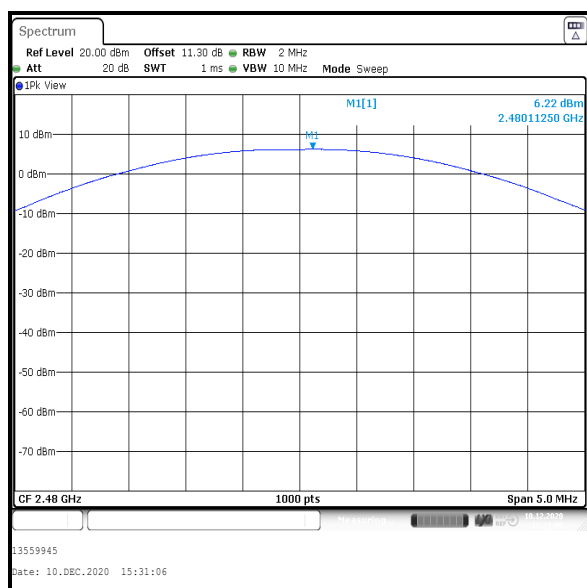
Channel	Conducted Peak Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
Bottom	5.8	3.5	9.3	36.0	26.7	Complied
Middle	6.2	4.3	10.5	36.0	25.5	Complied
Top	6.2	3.6	9.8	36.0	26.2	Complied

**Transmitter Maximum Peak Output Power (continued)****Results: DH1****Bottom Channel****Middle Channel****Top Channel**

**Transmitter Maximum Peak Output Power (continued)****Results: 2DH1**

Channel	Conducted Peak Power (dBm)	Conducted Peak Power Limit (dBm)	Margin (dB)	Result
Bottom	5.8	21.0	15.2	Complied
Middle	6.2	21.0	14.8	Complied
Top	6.2	21.0	14.8	Complied

Channel	Conducted Peak Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
Bottom	5.8	3.5	9.3	27.0	17.7	Complied
Middle	6.2	4.3	10.5	27.0	16.5	Complied
Top	6.2	3.6	9.8	27.0	17.2	Complied

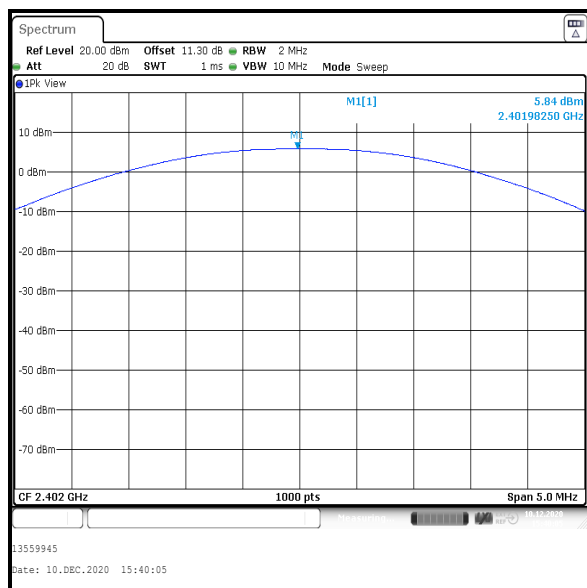
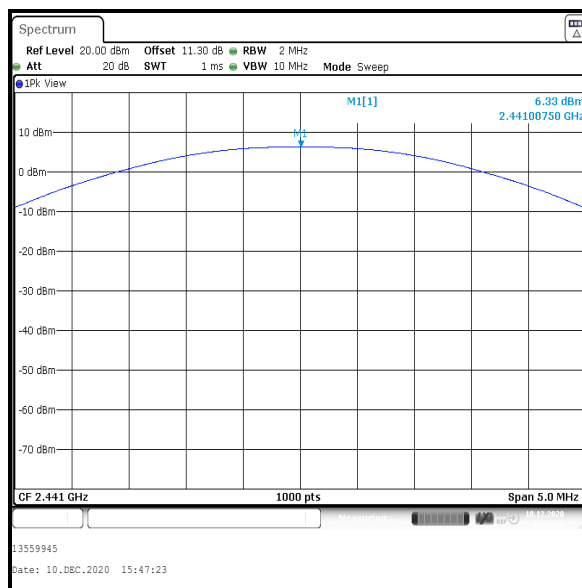
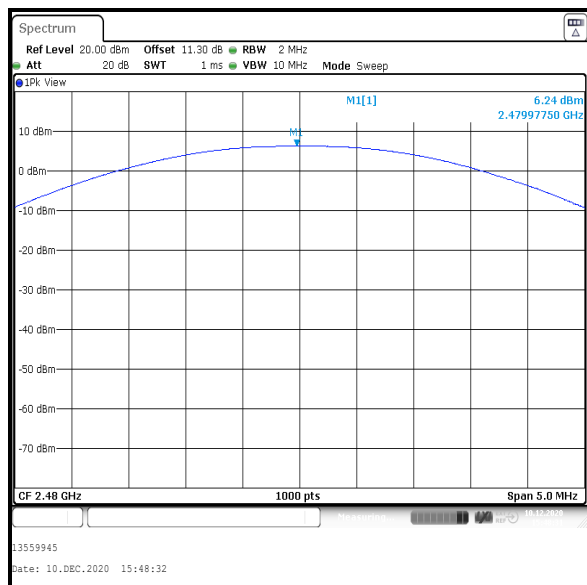
**Transmitter Maximum Peak Output Power (continued)****Results: 2DH1****Bottom Channel****Middle Channel****Top Channel**

**Transmitter Maximum Peak Output Power (continued)****Results: 3DH1**

Channel	Conducted Peak Power (dBm)	Conducted Peak Power Limit (dBm)	Margin (dB)	Result
Bottom	5.8	21.0	15.2	Complied
Middle	6.3	21.0	14.7	Complied
Top	6.2	21.0	14.8	Complied

Channel	Conducted Peak Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
Bottom	5.8	3.5	9.3	27.0	17.7	Complied
Middle	6.3	4.3	10.6	27.0	16.4	Complied
Top	6.2	3.6	9.8	27.0	17.2	Complied

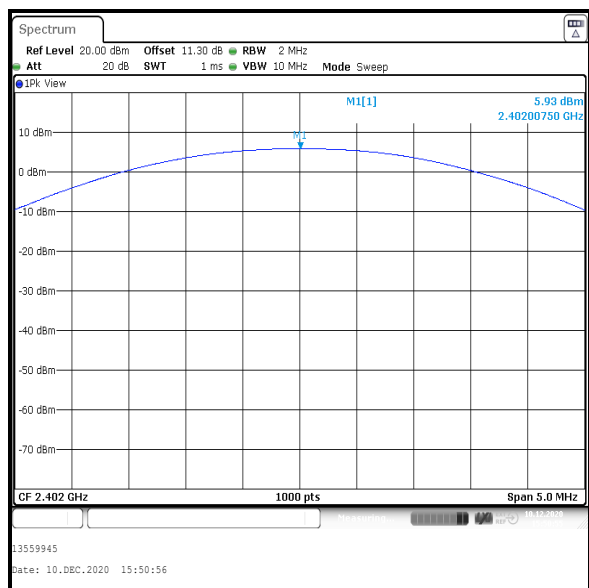
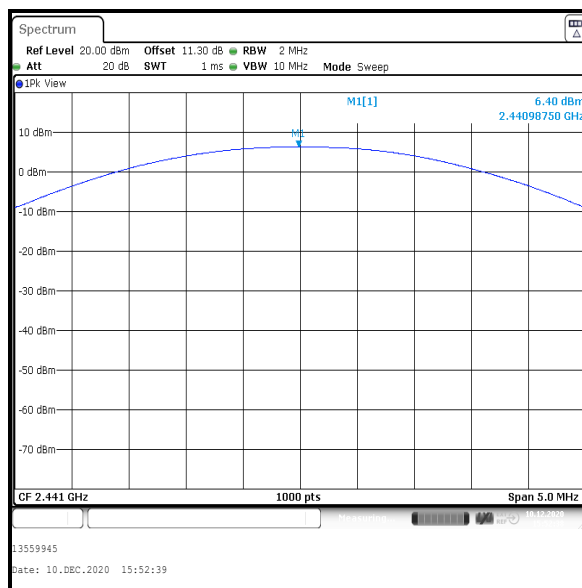
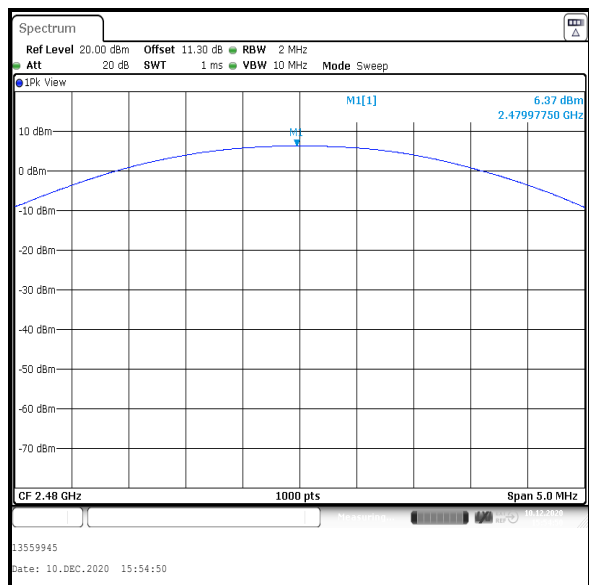


**Transmitter Maximum Peak Output Power (continued)****Results: 3DH1****Bottom Channel****Middle Channel****Top Channel**

**Transmitter Maximum Peak Output Power (continued)****Results: 3DH5**

Channel	Conducted Peak Power (dBm)	Conducted Peak Power Limit (dBm)	Margin (dB)	Result
Bottom	5.9	21.0	15.1	Complied
Middle	6.4	21.0	14.6	Complied
Top	6.4	21.0	14.6	Complied

Channel	Conducted Peak Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
Bottom	5.9	3.5	9.4	27.0	17.6	Complied
Middle	6.4	4.3	10.7	27.0	16.3	Complied
Top	6.4	3.6	10.0	27.0	17.0	Complied

**Transmitter Maximum Peak Output Power (continued)****Results: 3DH5****Bottom Channel****Middle Channel****Top Channel**

## **5. Radiated Test Results**

### **5.1. Transmitter Radiated Emissions <1 GHz**

#### **Test Summary:**

<b>Test Engineers:</b>	Marco Zunarelli & Nick Tye	<b>Test Dates:</b>	24 November 2020 & 30 March 2021
<b>Test Sample Serial Number:</b>	F0T047300000VX903		

<b>FCC 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>	ANSI C63.10 Sections 6.3 and 6.5
<b>Frequency Range</b>	9 kHz to 1000 MHz

#### **Environmental Conditions:**

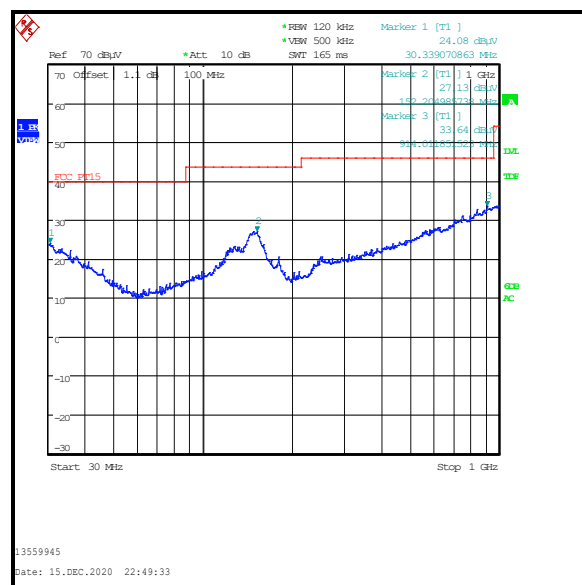
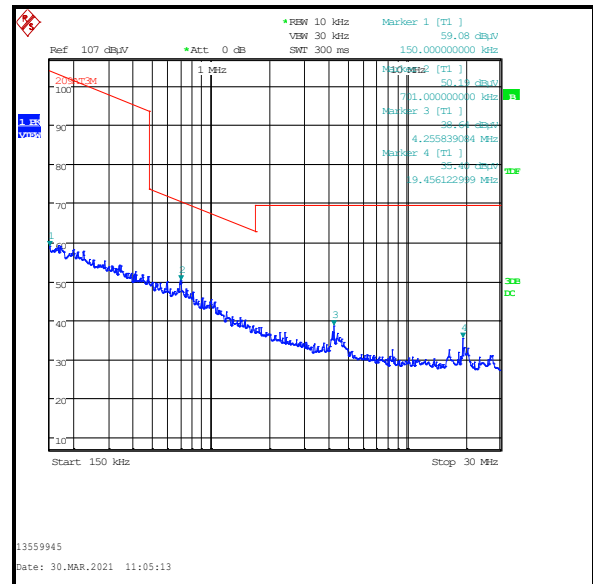
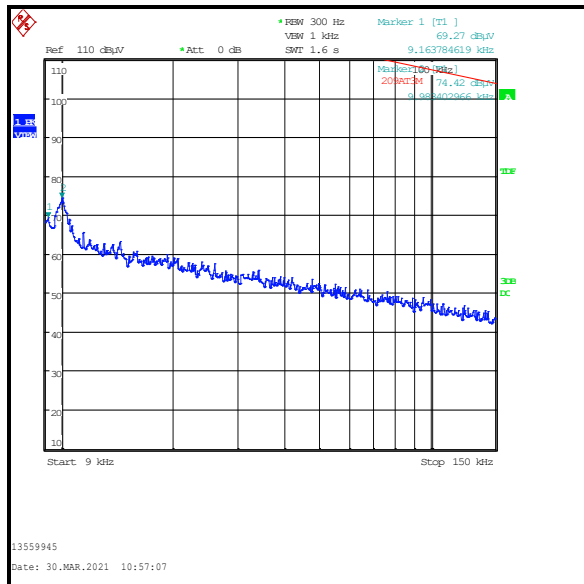
<b>Temperature (°C):</b>	21 to 22
<b>Relative Humidity (%):</b>	39 to 43

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

1. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
2. No spurious emissions were detected above the noise floor of the measuring receiver therefore the highest peak noise floor reading of the measuring receiver was recorded as shown in the table below.
3. Measurements below 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 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.
4. Pre-scans were performed and markers placed on the highest measured levels. The test receiver was configured as follows: For 9 kHz to 150 kHz, 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, 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: Peak / 2DH1**

Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
914.012	Horizontal	33.6	46.0	12.4	Complied



## **5.2. Transmitter Radiated Emissions >1 GHz**

### **Test Summary:**

<b>Test Engineer:</b>	Marco Zunarelli	<b>Test Dates:</b>	10 December 2020 to 15 December 2020
<b>Test Sample Serial Number:</b>	F0T047300000VX903		

<b>FCC 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>	ANSI C63.10 Sections 6.3 and 6.6
<b>Frequency Range</b>	1 GHz to 26.5 GHz

### **Environmental Conditions:**

<b>Temperature (°C):</b>	19 to 21
<b>Relative Humidity (%):</b>	39 to 42

### **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 emission shown on the 1 GHz to 3 GHz plot is the EUT fundamental at 2441 MHz.
3. \*The corrected average level has been obtained by subtracting the calculated duty cycle correction factor from the measured peak level for any restricted band emissions related to the fundamental. See Appendix 1 for further information.
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.
5. 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.
6. 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. Peak and average measurements were performed with their own appropriate detectors during the pre-scan measurements.

**Transmitter Radiated Emissions (continued)****Results: Peak / Bottom Channel / 2DH1**

Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
4803.704	Horizontal	53.0	74.0	21.0	Complied

**Results: Average / Bottom Channel / 2DH1**

Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
4803.704	Horizontal	33.0*	54.0	21.0	Complied

**Results: Peak / Middle Channel / 2DH1**

Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
4882.337	Horizontal	54.4	74.0	19.6	Complied

**Results: Average / Middle Channel / 2DH1**

Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
4882.337	Horizontal	34.4*	54.0	19.6	Complied

**Results: Peak / Top Channel / 2DH1**

Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
4959.800	Horizontal	56.2	74.0	17.8	Complied

**Results: Average / Top Channel / 2DH1**

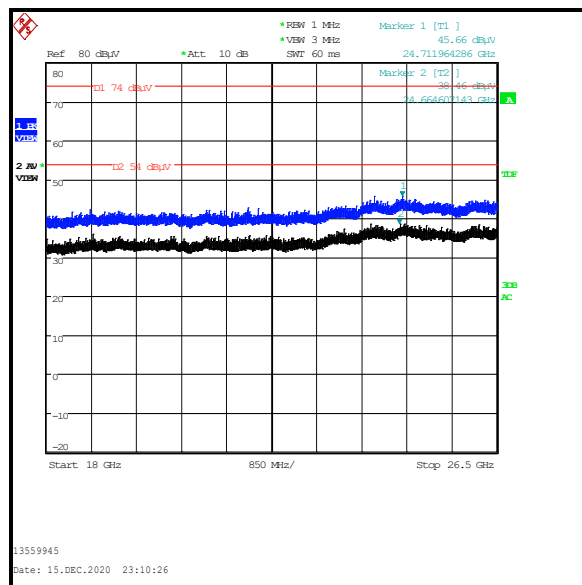
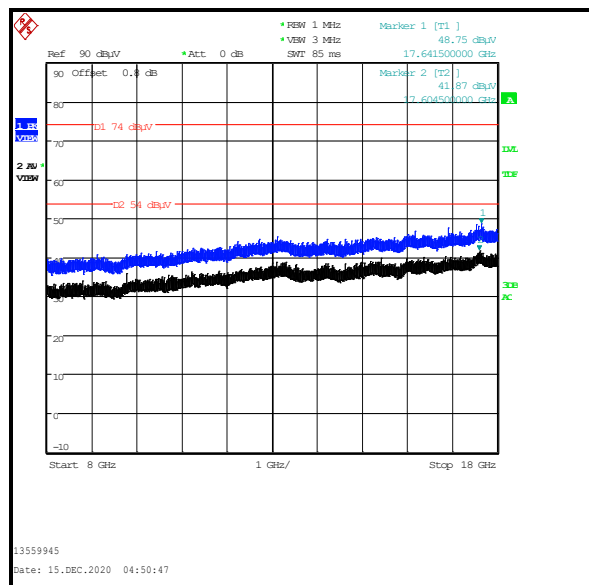
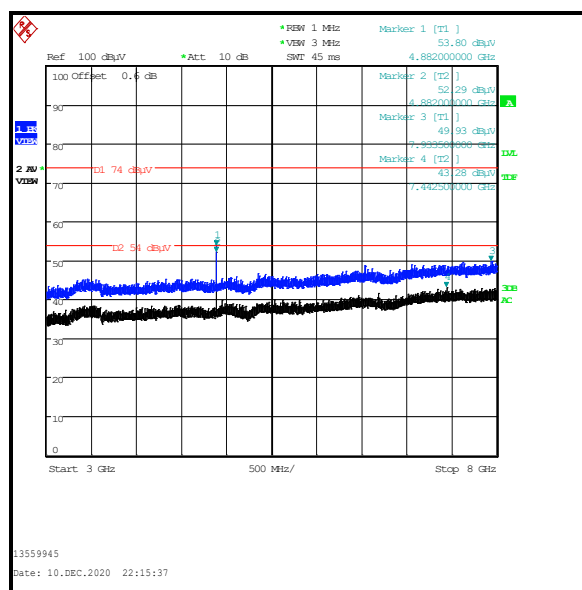
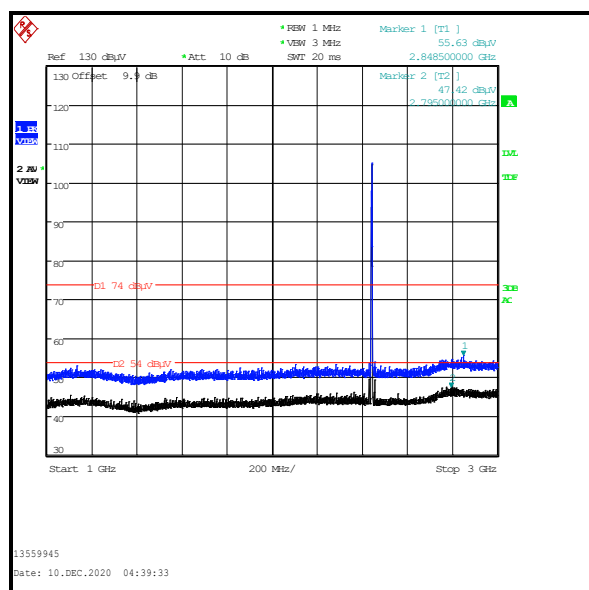
Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
4959.800	Horizontal	36.2*	54.0	17.8	Complied

**Results: Peak / Hopping Mode / 2DH1**

Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
4930.192	Horizontal	52.1	74.0	21.9	Complied

**Results: Average / Hopping Mode / 2DH1**

Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
4930.192	Horizontal	32.1*	54.0	21.9	Complied

**Transmitter Radiated Emissions (continued)**

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



### **5.3. Transmitter Band Edge Radiated Emissions**

#### **Test Summary:**

<b>Test Engineer:</b>	Marco Zunarelli	<b>Test Dates:</b>	14 December 2020 & 15 December 2020
<b>Test Sample Serial Number:</b>	F0T047300000VX903		

<b>FCC 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>	ANSI C63.10 Section 6.10

#### **Environmental Conditions:**

<b>Temperature (°C):</b>	22
<b>Relative Humidity (%):</b>	42

#### **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 lower band edge is adjacent to a non-restricted band. 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. A marker was placed on the band edge spot frequencies and a second marker placed on the highest emission level in the adjacent band (where a higher level emission was present). Marker frequencies and levels were recorded.
3. The upper band edge is adjacent to a restricted band. The test receiver resolution bandwidth was set to 1 MHz and video bandwidth 3 MHz. Peak and average measurements were performed with their respective detectors, 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 was placed on the band edge spot frequencies and a second marker placed on the highest emission level in the adjacent band (where a higher level emission was present). Marker frequencies and levels were recorded.
4. 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.
5. \* -20 dBc limit.
6. \*\*The corrected average level has been obtained by subtracting the calculated duty cycle correction factor from the measured peak level for any restricted band emissions related to the fundamental. See Appendix 1 for further information.

**Transmitter Band Edge Radiated Emissions (continued)****Results: Static Mode / DH1**

Frequency (MHz)	Antenna Polarity	Peak Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2390.001	Horizontal	46.8	81.8*	35.0	Complied
2400	Horizontal	44.9	81.8*	36.9	Complied
2483.5	Horizontal	57.9	74.0	16.1	Complied
2492.154	Horizontal	54.4	74.0	19.6	Complied

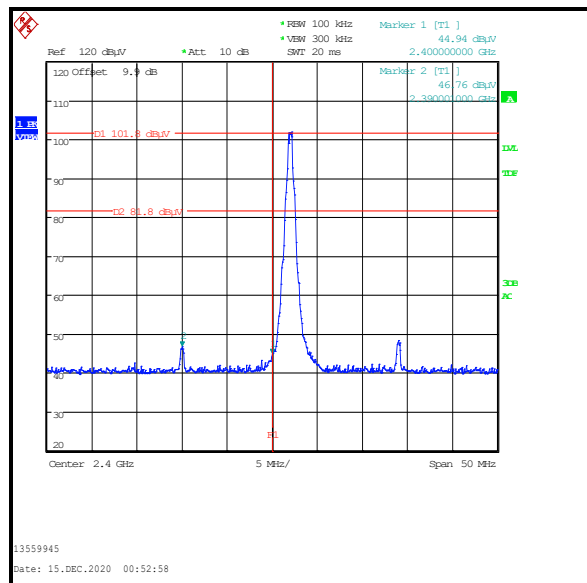
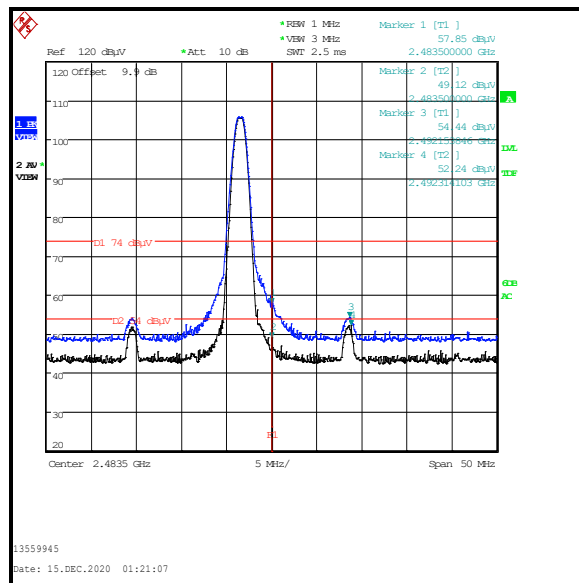
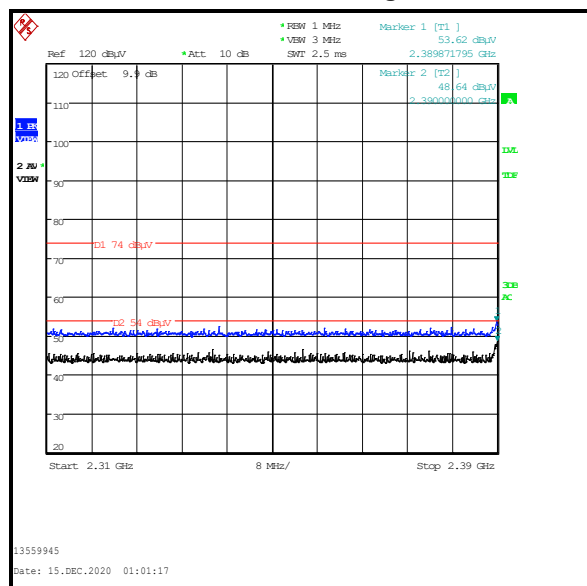
Frequency (MHz)	Antenna Polarity	Average Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2483.5	Horizontal	37.9**	54.0	16.1	Complied
2492.154	Horizontal	34.4**	54.0	19.6	Complied

**Results: 2310 MHz to 2390 MHz Restricted Band / Peak**

Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2389.872	Horizontal	53.6	74.0	20.4	Complied

**Results: 2310 MHz to 2390 MHz Restricted Band / Average**

Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2389.872	Horizontal	33.6**	54.0	20.4	Complied

**Transmitter Band Edge Radiated Emissions (continued)****Results: Static Mode / DH1****Lower Band Edge****Upper Band Edge****2310 MHz to 2390 MHz Restricted Band**

**Transmitter Band Edge Radiated Emissions (continued)****Results: Hopping Mode / DH1**

Frequency (MHz)	Antenna Polarity	Peak Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2400	Horizontal	47.4	83.1*	35.7	Complied
2483.5	Horizontal	51.3	74.0	22.7	Complied
2491.192	Horizontal	53.9	74.0	20.1	Complied

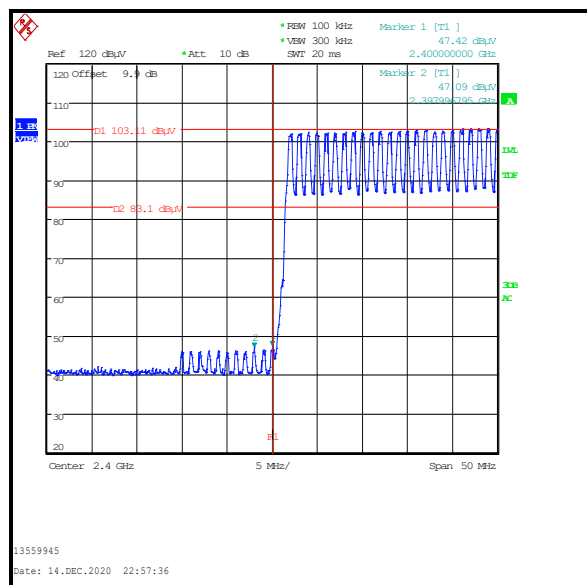
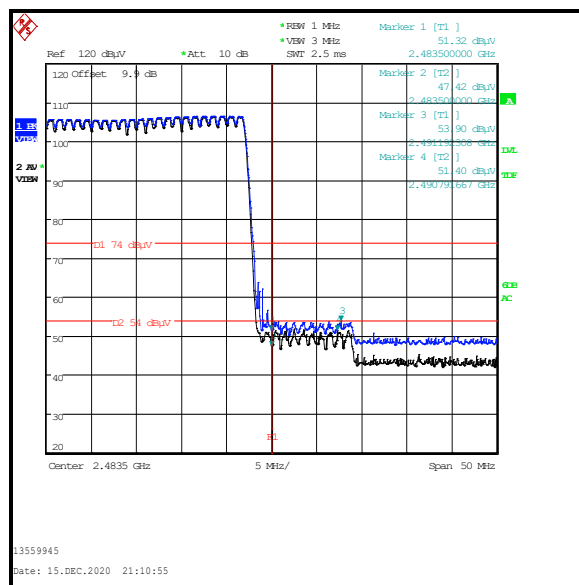
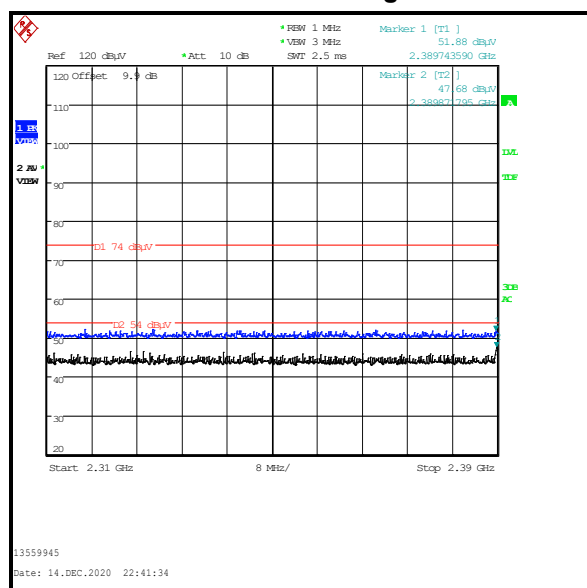
Frequency (MHz)	Antenna Polarity	Average Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2483.5	Horizontal	31.3**	54.0	22.7	Complied
2491.192	Horizontal	33.9**	54.0	20.1	Complied

**Results: 2310 MHz to 2390 MHz Restricted Band / Peak**

Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2389.744	Horizontal	51.9	74.0	22.1	Complied

**Results: 2310 MHz to 2390 MHz Restricted Band / Average**

Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2389.744	Horizontal	31.9**	54.0	22.1	Complied

**Transmitter Band Edge Radiated Emissions (continued)****Results: Hopping Mode / DH1****Lower Band Edge****Upper Band Edge****2310 MHz to 2390 MHz Restricted Band**

**Transmitter Band Edge Radiated Emissions (continued)****Results: Static Mode / 2DH1**

Frequency (MHz)	Antenna Polarity	Peak Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2390.001	Horizontal	46.5	81.8*	35.3	Complied
2400	Horizontal	44.6	81.8*	37.2	Complied
2483.5	Horizontal	58.6	74.0	15.4	Complied

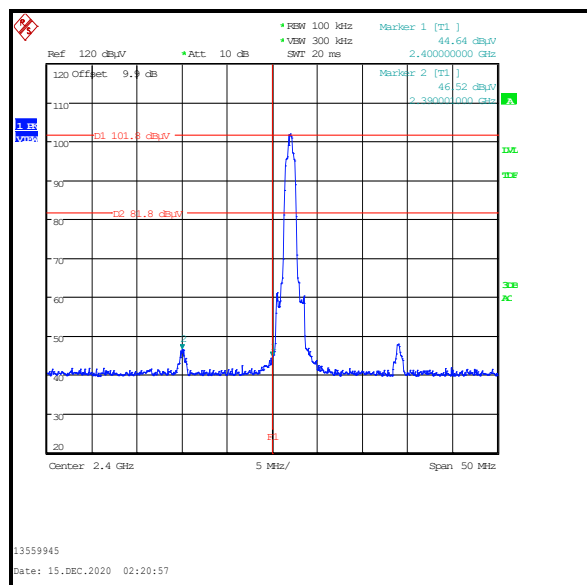
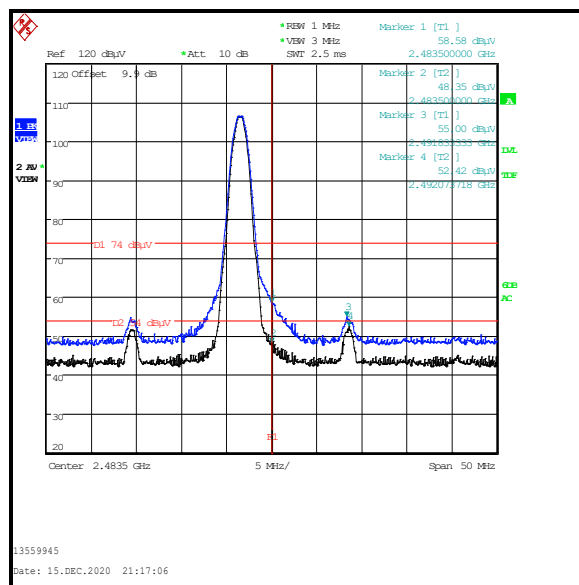
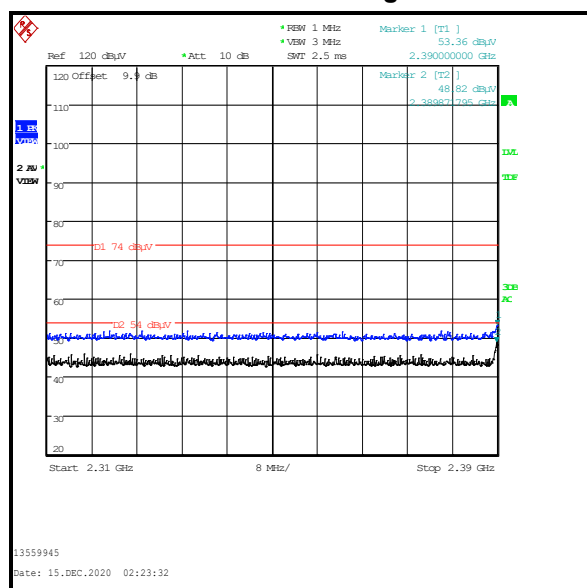
Frequency (MHz)	Antenna Polarity	Average Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2483.5	Horizontal	38.6**	54.0	15.4	Complied
2491.833	Horizontal	35.0**	54.0	19.0	Complied

**Results: 2310 MHz to 2390 MHz Restricted Band / Peak**

Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2390.000	Horizontal	53.4	74.0	20.6	Complied

**Results: 2310 MHz to 2390 MHz Restricted Band / Average**

Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2390.000	Horizontal	33.4**	54.0	20.6	Complied

**Transmitter Band Edge Radiated Emissions (continued)****Results: Static Mode / 2DH1****Lower Band Edge****Upper Band Edge****2310 MHz to 2390 MHz Restricted Band**

**Transmitter Band Edge Radiated Emissions (continued)****Results: Hopping Mode / 2DH1**

Frequency (MHz)	Antenna Polarity	Peak Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2399.038	Horizontal	46.1	83.1*	37.0	Complied
2400	Horizontal	43.4	83.1*	39.7	Complied
2483.5	Horizontal	59.2	74.0	14.8	Complied

Frequency (MHz)	Antenna Polarity	Average Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2483.5	Horizontal	39.2**	54.0	14.8	Complied
2483.981	Horizontal	37.5**	54.0	18.6	Complied

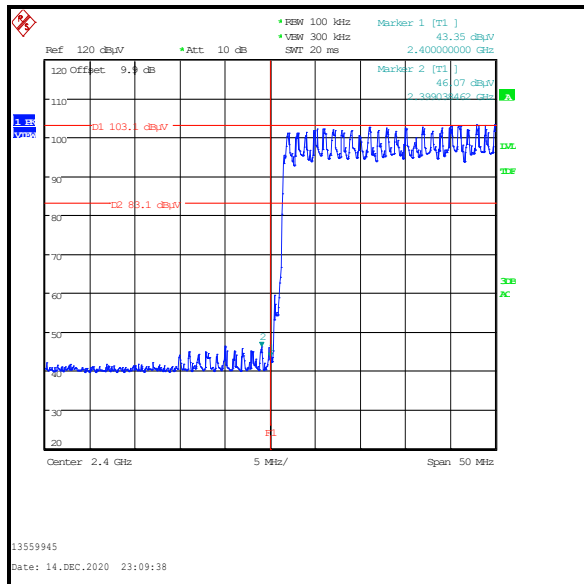
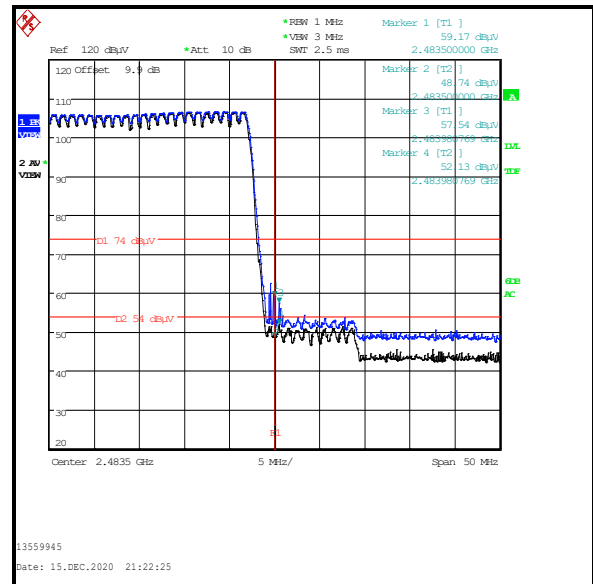
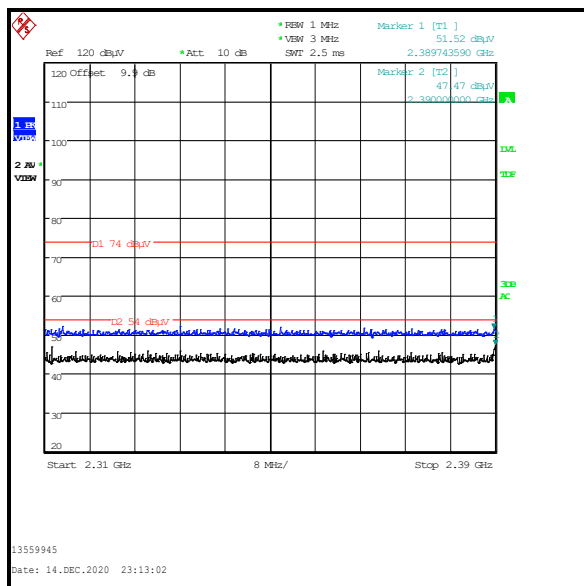
**Results: 2310 MHz to 2390 MHz Restricted Band / Peak**

Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2389.744	Horizontal	51.5	74.0	22.5	Complied

**Results: 2310 MHz to 2390 MHz Restricted Band / Average**

Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2389.744	Horizontal	31.5**	54.0	22.5	Complied



**Transmitter Band Edge Radiated Emissions (continued)****Results: Hopping Mode / 2DH1****Lower Band Edge****Upper Band Edge****2310 MHz to 2390 MHz Restricted Band**

**Transmitter Band Edge Radiated Emissions (continued)****Results: Static Mode / 3DH1**

Frequency (MHz)	Antenna Polarity	Peak Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2390.001	Horizontal	46.5	81.7*	35.2	Complied
2400	Horizontal	43.6	81.7*	38.1	Complied
2483.5	Horizontal	57.8	74.0	16.5	Complied

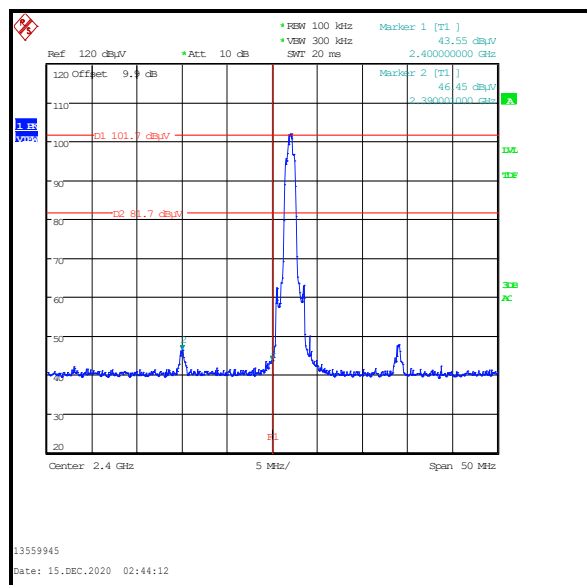
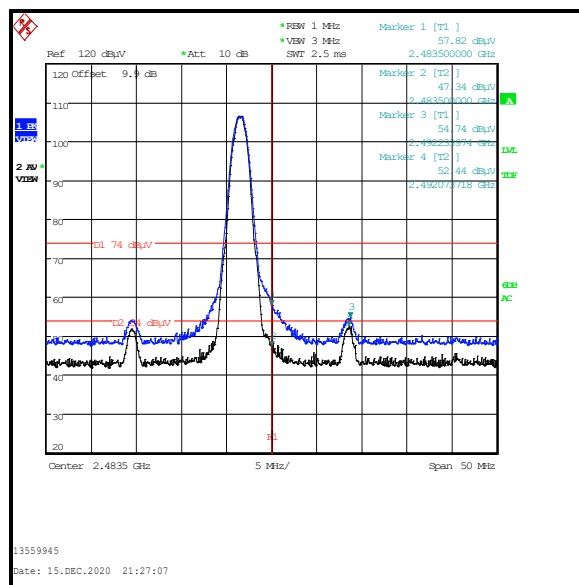
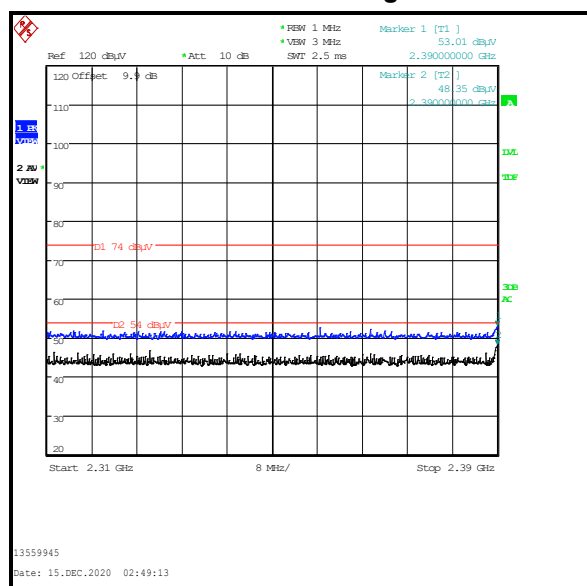
Frequency (MHz)	Antenna Polarity	Average Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2483.5	Horizontal	37.8**	54.0	16.5	Complied
2492.234	Horizontal	34.7**	54.0	19.3	Complied

**Results: 2310 MHz to 2390 MHz Restricted Band / Peak**

Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2390.000	Horizontal	53.0	74.0	21.0	Complied

**Results: 2310 MHz to 2390 MHz Restricted Band / Average**

Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2390.000	Horizontal	33.0**	54.0	21.0	Complied

**Transmitter Band Edge Radiated Emissions (continued)****Results: Static Mode / 3DH1****Lower Band Edge****Upper Band Edge****2310 MHz to 2390 MHz Restricted Band**

**Transmitter Band Edge Radiated Emissions (continued)****Results: Hopping Mode / 3DH1**

Frequency (MHz)	Antenna Polarity	Peak Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2397.997	Horizontal	46.0	83.1*	37.1	Complied
2400	Horizontal	45.4	83.1*	37.7	Complied
2483.5	Horizontal	53.9	74.0	20.1	Complied

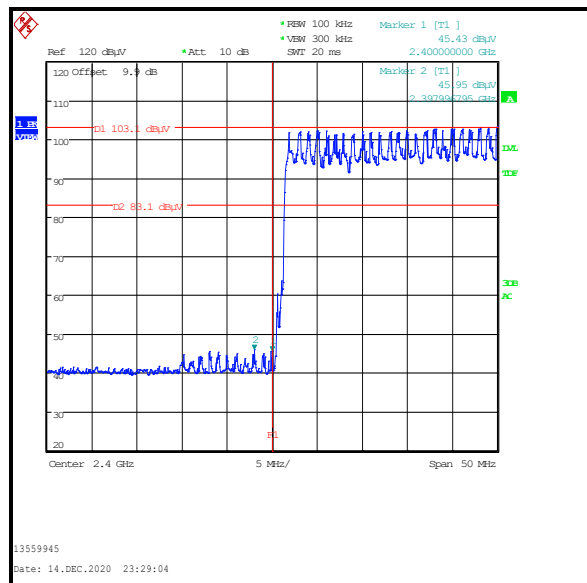
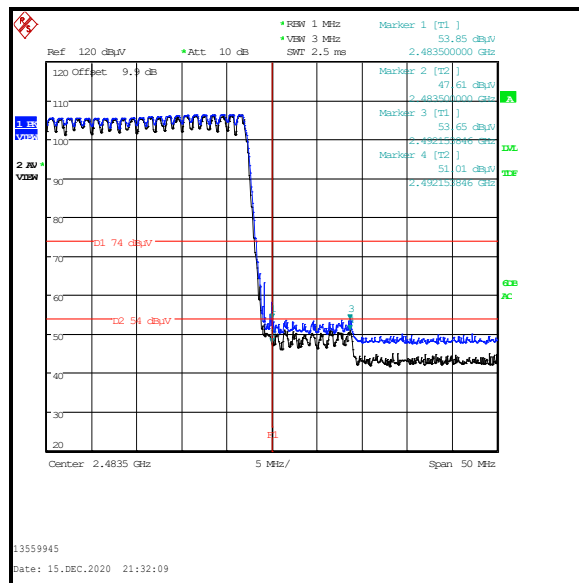
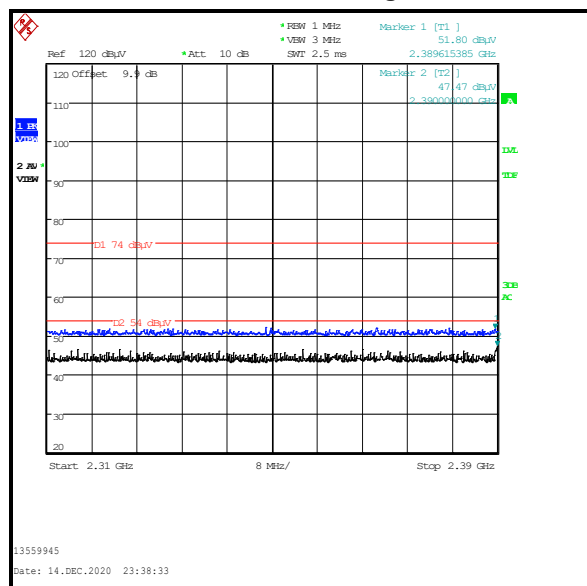
Frequency (MHz)	Antenna Polarity	Average Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2483.5	Horizontal	33.9**	54.0	20.1	Complied
2492.154	Horizontal	33.7**	54.0	20.3	Complied

**Results: 2310 MHz to 2390 MHz Restricted Band / Peak**

Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2389.615	Horizontal	51.8	74.0	22.2	Complied

**Results: 2310 MHz to 2390 MHz Restricted Band / Average**

Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2389.615	Horizontal	31.8**	54.0	22.2	Complied

**Transmitter Band Edge Radiated Emissions (continued)****Results: Hopping Mode / 3DH1****Lower Band Edge****Upper Band Edge****2310 MHz to 2390 MHz Restricted Band**

**Transmitter Band Edge Radiated Emissions (continued)****Results: Static Mode / 3DH5**

Frequency (MHz)	Antenna Polarity	Peak Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2390.001	Horizontal	46.3	81.8*	35.5	Complied
2400	Horizontal	42.4	81.8*	39.4	Complied
2483.5	Horizontal	60.6	74.0	13.4	Complied

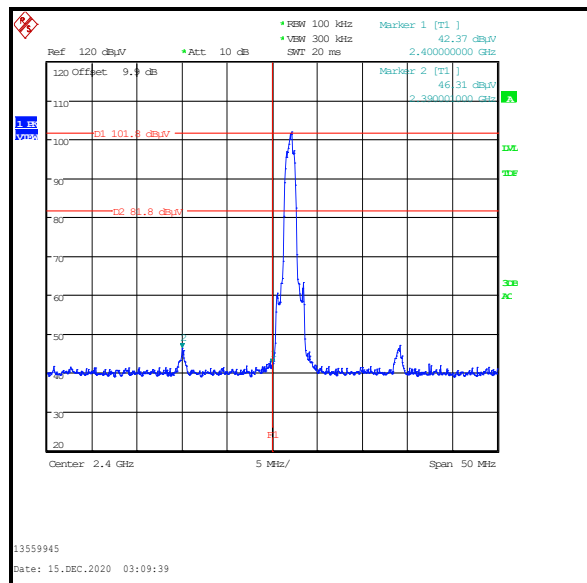
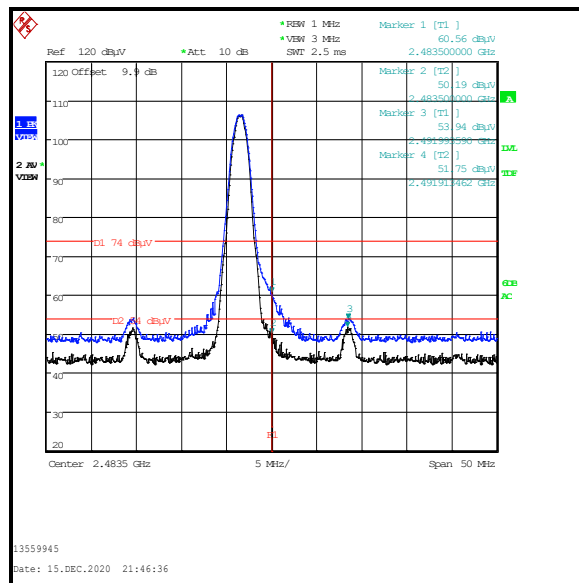
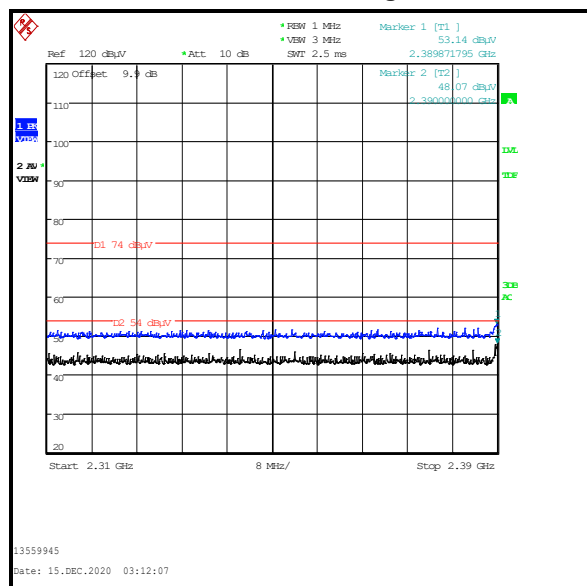
Frequency (MHz)	Antenna Polarity	Average Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2483.5	Horizontal	41.6**	54.0	12.4	Complied
2491.994	Horizontal	34.9**	54.0	19.1	Complied

**Results: 2310 MHz to 2390 MHz Restricted Band / Peak**

Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2389.872	Horizontal	53.1	74.0	20.9	Complied

**Results: 2310 MHz to 2390 MHz Restricted Band / Average**

Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2389.872	Horizontal	34.1**	54.0	19.9	Complied

**Transmitter Band Edge Radiated Emissions (continued)****Results: Static Mode / 3DH5****Lower Band Edge****Upper Band Edge****2310 MHz to 2390 MHz Restricted Band**

**Transmitter Band Edge Radiated Emissions (continued)****Results: Hopping Mode / 3DH5**

Frequency (MHz)	Antenna Polarity	Peak Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2393.109	Horizontal	46.2	82.5*	36.3	Complied
2400	Horizontal	45.3	82.5*	37.2	Complied
2483.5	Horizontal	54.2	74.0	19.8	Complied

Frequency (MHz)	Antenna Polarity	Average Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2483.5	Horizontal	35.2**	54.0	18.8	Complied
2484.221	Horizontal	34.1**	54.0	19.9	Complied

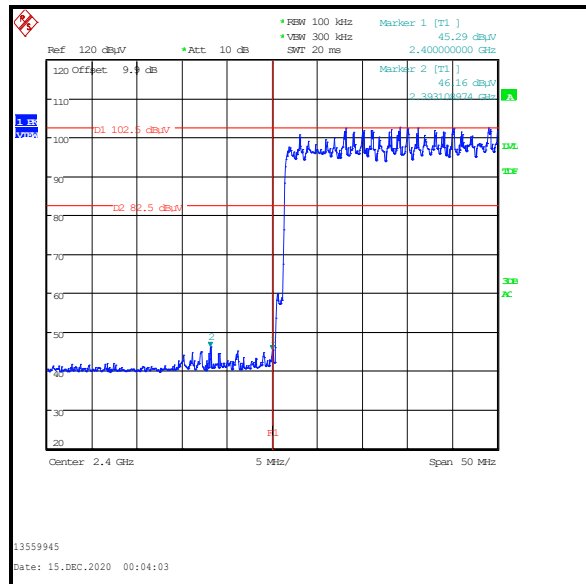
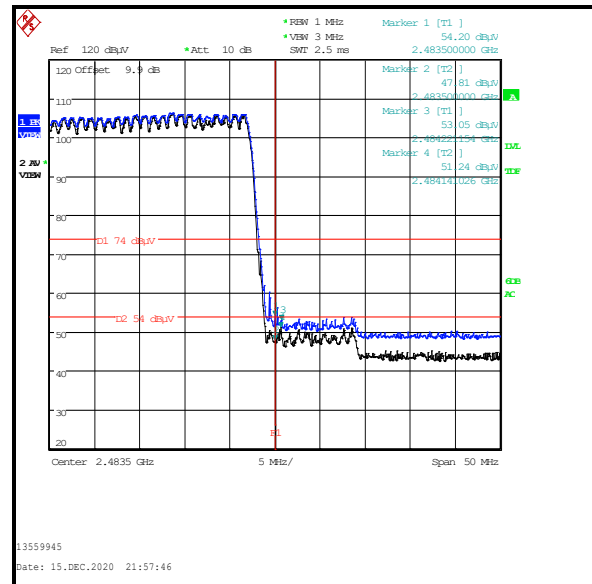
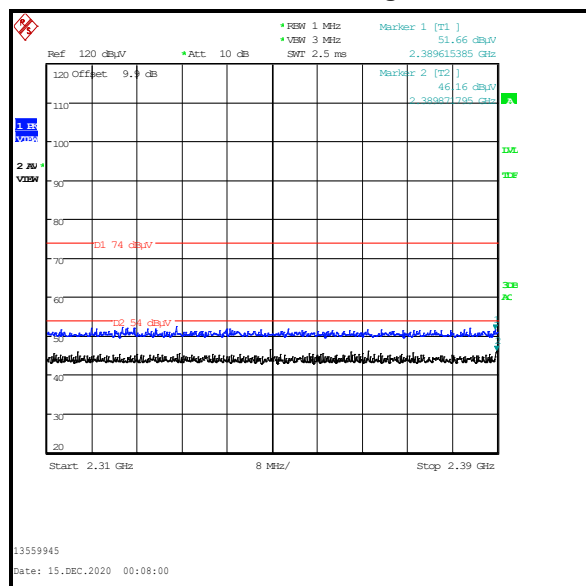
**Results: 2310 MHz to 2390 MHz Restricted Band / Peak**

Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2389.615	Horizontal	51.7	74.0	22.3	Complied

**Results: 2310 MHz to 2390 MHz Restricted Band / Average**

Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2389.615	Horizontal	32.7**	54.0	21.3	Complied



**Transmitter Band Edge Radiated Emissions (continued)****Results: Hopping Mode / 3DH5****Lower Band Edge****Upper Band Edge****2310 MHz to 2390 MHz Restricted Band**

## **6. AC Power Line Conducted Emissions Test Results**

### **6.1. Transmitter AC Conducted Spurious Emissions**

#### **Test Summary:**

<b>Test Engineer:</b>	Matthew Botfield	<b>Test Date:</b>	30 March 2021
<b>Test Sample Serial Number:</b>	F0T040200090JH307		

<b>FCC Reference:</b>	Part 15.207
<b>ISED Canada Reference:</b>	RSS-Gen 8.8
<b>Test Method Used:</b>	ANSI C63.10 Section 6.2 / FCC KDB 174176 and notes below

#### **Environmental Conditions:**

<b>Temperature (°C):</b>	22
<b>Relative Humidity (%):</b>	41

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

1. The EUT was plugged into a USB cable which is connected to an AC charger. The AC charger was connected to 120 VAC 60 Hz single phase supply via a LISN.
2. In accordance with FCC KDB 174176 Q4, tests were performed with a 240 VAC 60 Hz single phase supply as this was within the voltage range marked on the power supply.
3. A pulse limiter was fitted between the LISN and the test receiver.
4. Pre-scans were performed and markers placed on the highest live and neutral measured levels. Final measurements were performed on the marker frequencies and the results entered into the tables below.

**Transmitter AC Conducted Spurious Emissions (continued)****Results: Live / Quasi Peak / 120 VAC 60 Hz**

Frequency (MHz)	Line	Level (dB $\mu$ V)	Limit (dB $\mu$ V)	Margin (dB)	Result
0.164	Live	43.4	65.3	21.9	Complied
0.249	Live	38.0	61.8	23.8	Complied
0.326	Live	33.5	59.6	26.1	Complied
0.798	Live	34.2	56.0	21.8	Complied
0.803	Live	33.6	56.0	22.4	Complied
7.211	Live	27.3	60.0	32.7	Complied

**Results: Live / Average / 120 VAC 60 Hz**

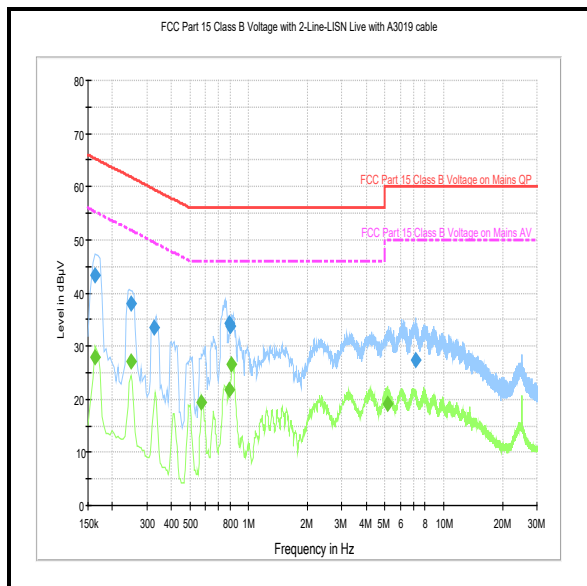
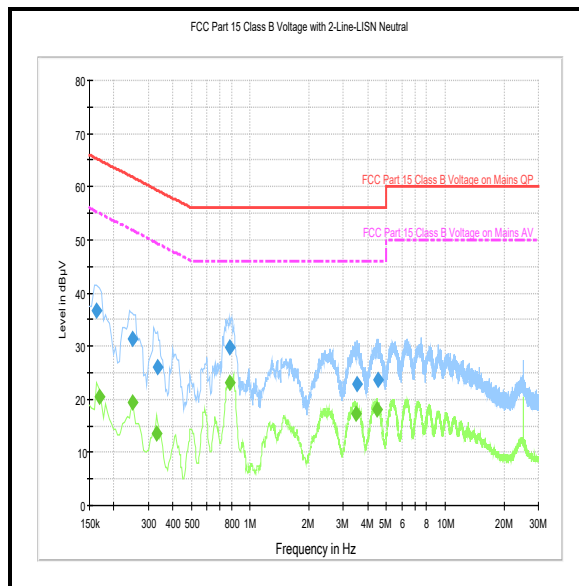
Frequency (MHz)	Line	Level (dB $\mu$ V)	Limit (dB $\mu$ V)	Margin (dB)	Result
0.164	Live	28.0	55.3	27.3	Complied
0.249	Live	27.1	51.8	24.7	Complied
0.573	Live	19.5	46.0	26.5	Complied
0.798	Live	21.8	46.0	24.2	Complied
0.816	Live	26.6	46.0	19.4	Complied
5.123	Live	19.1	50.0	30.9	Complied

**Results: Neutral / Quasi Peak / 120 VAC 60 Hz**

Frequency (MHz)	Line	Level (dB $\mu$ V)	Limit (dB $\mu$ V)	Margin (dB)	Result
0.164	Neutral	36.7	65.3	28.6	Complied
0.249	Neutral	31.4	61.8	30.4	Complied
0.335	Neutral	26.1	59.3	33.2	Complied
0.789	Neutral	29.8	56.0	26.2	Complied
3.530	Neutral	23.0	56.0	33.0	Complied
4.506	Neutral	23.7	56.0	32.3	Complied

**Results: Neutral / Average / 120 VAC 60 Hz**

Frequency (MHz)	Line	Level (dB $\mu$ V)	Limit (dB $\mu$ V)	Margin (dB)	Result
0.168	Neutral	20.4	55.1	34.7	Complied
0.249	Neutral	19.4	51.8	32.4	Complied
0.330	Neutral	13.7	49.5	35.8	Complied
0.789	Neutral	23.0	46.0	23.0	Complied
3.471	Neutral	17.3	46.0	28.7	Complied
4.484	Neutral	18.0	46.0	28.0	Complied

**Transmitter AC Conducted Spurious Emissions (continued)****Results: 120 VAC 60 Hz****Live****Neutral**

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

**Transmitter AC Conducted Spurious Emissions (continued)****Results: Live / Quasi Peak / 240 VAC 60 Hz**

Frequency (MHz)	Line	Level (dB $\mu$ V)	Limit (dB $\mu$ V)	Margin (dB)	Result
0.150	Live	29.2	66.0	36.8	Complied
0.717	Live	19.9	56.0	36.1	Complied
0.821	Live	26.2	56.0	29.8	Complied
2.247	Live	20.1	56.0	35.9	Complied
3.858	Live	21.5	56.0	34.5	Complied
5.262	Live	22.2	60.0	37.8	Complied

**Results: Live / Average / 240 VAC 60 Hz**

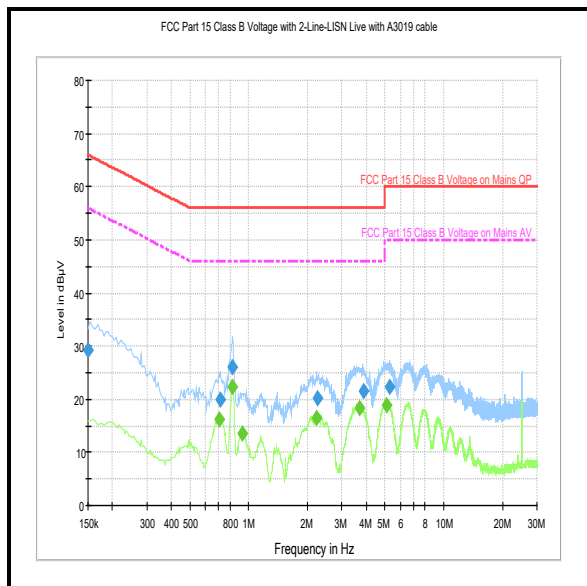
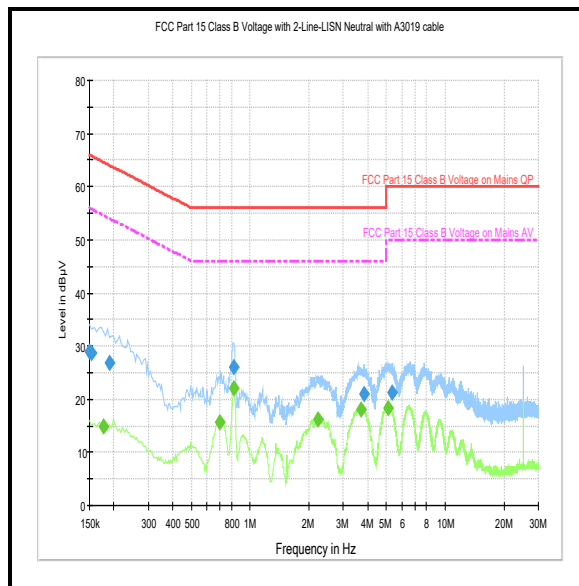
Frequency (MHz)	Line	Level (dB $\mu$ V)	Limit (dB $\mu$ V)	Margin (dB)	Result
0.704	Live	16.2	46.0	29.8	Complied
0.825	Live	22.4	46.0	23.6	Complied
0.929	Live	13.7	46.0	32.3	Complied
2.211	Live	16.4	46.0	29.6	Complied
3.696	Live	18.3	46.0	27.7	Complied
5.073	Live	18.8	50.0	31.2	Complied

**Results: Neutral / Quasi Peak / 240 VAC 60 Hz**

Frequency (MHz)	Line	Level (dB $\mu$ V)	Limit (dB $\mu$ V)	Margin (dB)	Result
0.150	Neutral	29.1	66.0	36.9	Complied
0.155	Neutral	28.8	65.8	37.0	Complied
0.191	Neutral	26.8	64.0	37.2	Complied
0.825	Neutral	25.9	56.0	30.1	Complied
3.822	Neutral	21.1	56.0	34.9	Complied
5.366	Neutral	21.3	60.0	38.7	Complied

**Results: Neutral / Average / 240 VAC 60 Hz**

Frequency (MHz)	Line	Level (dB $\mu$ V)	Limit (dB $\mu$ V)	Margin (dB)	Result
0.177	Neutral	15.0	54.6	39.6	Complied
0.699	Neutral	15.8	46.0	30.2	Complied
0.825	Neutral	22.1	46.0	24.0	Complied
2.211	Neutral	16.2	46.0	29.8	Complied
3.705	Neutral	18.1	46.0	27.9	Complied
5.087	Neutral	18.4	50.0	31.6	Complied

**Transmitter AC Conducted Spurious Emissions (continued)****Results: 240 VAC 60 Hz****Live****Neutral**

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

## **Appendix 1**

### **FHSS Duty Cycle Correction Factor Calculation**

In accordance with KDB 558074 section 9 and ANSI C63.10 section 7.5, a duty cycle correction factor may be applied to calculate the average radiated field strength emission levels for an FHSS device.

For DH1, 2DH1, 3DH1 and 3DH5 *Bluetooth* signals, the following values were taken from the *Bluetooth* Core Specification V5.0 to give the worst case correction:

Modulation	DH1, 2DH1, 3DH1	3DH5
Channel Hopping Rate (Hops/s)	1600	1600
Tx Timeslots	1	5
Rx Timeslots	1	1
Adjusted Hopping Rate for Adaptive Frequency Hopping (Hops/s)	800	266.667
Time per Hop (ms)	1.25	3.75
Minimum Number of Channels	20	20
Time per Hop Sequence (ms)	25	75
Maximum Number of Hops on One Channel in any 100 ms Observation Period	5	3
Maximum Dwell Time on One Channel in any 100 ms Observation Period (ms)	6.25	11.25
Calculated Duty cycle correction factor applied (dB)	24.1	19.0
Maximum Duty cycle correction factor applied (dB)	20.0	19.0

\*Note: If the duty cycle correction factor is calculated to be > 20 dB then 20 dB correction factor applies.

The duty cycle correction factor was calculated based on the above values:

$$DH1, 2DH1, 3DH1: 20 * \log(6 \text{ ms} / 100 \text{ ms}) = 24.1 \text{ dB}^*$$

$$3DH5: 20 * \log(11.25 \text{ ms} / 100 \text{ ms}) = 19.0 \text{ dB}$$

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