



# TEST REPORT

**Test Report No. :** UL-RPT-RP13591277-2016A

**Customer** : Buddi Limited

**Model No. / HVIN** : 3430412

**PMN** : Smart Tag 4

**FCC ID** : ZDLST5

**ISED Certification No.** : 20371-ST5

**Technology** : 2.4 GHz WLAN

**Test Standard(s)** : FCC Parts 15.209(a) & 15.247  
Innovation, Science and Economic Development Canada  
RSS-247 Issue 2 February 2017  
RSS-Gen Issue 5 February 2021

**Test Laboratory** : UL International (UK) Ltd, Basingstoke, Hampshire, RG24 8AH,  
United Kingdom

1. This test report shall not be reproduced except in full, without the written approval of UL International (UK) Ltd.
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 1.0

**Date of Issue:** 21 April 2021

**Checked by:**

Sarah Williams  
RF Operations Leader, Radio Laboratory

**Company Signatory:**

Ben Mercer  
Lead Project Engineer, Radio Laboratory



---

## UL International (UK) LTD

Unit 1-3 Horizon, Kingsland Business Park, Wade Road, Basingstoke, Hampshire, RG24 8AH, UK  
Telephone: +44 (0)1256 312000  
Facsimile: +44 (0)1256 312001

**Customer Information**

<b>Company Name:</b>	Buddi Limited
<b>Address:</b>	Talbot House 17 Church Street Rickmansworth Hertfordshire WD3 1DE United Kingdom

**Report Revision History**

<b>Version Number</b>	<b>Issue Date</b>	<b>Revision Details</b>	<b>Revised By</b>
1.0	21/04/2021	Initial Version	Sarah Williams

**Table of Contents**

<b>Customer Information.....</b>	<b>2</b>
<b>Report Revision History .....</b>	<b>2</b>
<b>1. Attestation of Test Results .....</b>	<b>4</b>
1.1. Description of EUT	4
1.2. General Information	4
1.3. Summary of Test Results	5
1.4. Deviations from the Test Specification	5
<b>2. Summary of Testing.....</b>	<b>6</b>
2.1. Facilities and Accreditation	6
2.2. Methods and Procedures	6
2.3. Calibration and Uncertainty	7
2.4. Test and Measurement Equipment	8
<b>3. Equipment Under Test (EUT) .....</b>	<b>10</b>
3.1. Identification of Equipment Under Test (EUT)	10
3.2. Modifications Incorporated in the EUT	10
3.3. Additional Information Related to Testing	11
3.4. Description of Available Antenna	11
3.5. Description of Test Setup	12
<b>4. Antenna Port Test Results .....</b>	<b>14</b>
4.1. Transmitter 99% Emission Bandwidth	14
4.2. Transmitter Minimum 6 dB Bandwidth	18
4.3. Transmitter Power Spectral Density	22
4.4. Transmitter Maximum (Average) Output Power	26
<b>5. Radiated Test Results .....</b>	<b>33</b>
5.1. Transmitter Radiated Emissions <1 GHz	33
5.2. Transmitter Radiated Emissions >1 GHz	36
5.3. Transmitter Band Edge Radiated Emissions	39

## **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 3G cellular module (FCC ID: ZDL3430005ST4, IC: 20371-3430005ST3G), a 2.4 GHz WLAN transceiver and a 915 MHz ISM transceiver.

### **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>	47CFR15.209
<b>Specification Title:</b>	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) – Section 15.209
<b>Specification Reference:</b>	RSS-Gen Issue 5 February 2021
<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: 3245B
<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>	08 February 2021 to 23 March 2021

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

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

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

1. For the data rates declared as worst case and reported in this test report, duty cycle was measured to be greater than 98%. Plots for these measurements are archived on the company IT server and available for inspection upon request.

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

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

## **2. Summary of Testing**

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

The test site and measurement facilities used to collect data are located at Unit 3 Horizon, Wade Road, Kingsland Business Park, Basingstoke, Hampshire, RG24 8AH, United Kingdom. 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	-
Site 2	-
Site 17	X

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

## **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 & Decision Rule**

#### **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
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%	±2.94 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 Minimum 6 dB Bandwidth, 99% Emission Bandwidth & Maximum (Average) Output Power

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2001	Thermohygrometer	Testo	608-H1	45041824	10 dec 2021	12
M2033	Signal Analyser	Rohde & Schwarz	FSV13	101667	24 Jul 2021	12
G0628	Signal Generator	Rohde & Schwarz	SMBV100A	261847	08 Oct 2023	36
A2919	Attenuator	AtlanTecRF	AN18W5-20	832828#4	Calibrated before use	-

### Test Equipment Used for Transmitter Power Spectral Density

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2002	Thermohygrometer	Testo	608-H1	45041825	10 Dec 2021	12
M2018	Signal Analyser	Rohde & Schwarz	FSV7	102699	01 Oct 2021	12
G0615	Signal Generator	Rohde & Schwarz	SMBV100A	260473	19 Mar 2023	36
A2527	Attenuator	AtlanTecRF	AN18W5-20	832828#2	Calibrated before use	-

### Test Equipment Used for Transmitter Radiated Emissions

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2003	Thermohygrometer	Testo	608-H1	45046641	10 Dec 2021	12
K0017	3m RSE Chamber	Rainford	N/A	N/A	21 Oct 2021	12
M1995	Test Receiver	Rohde & Schwarz	ESU40	100428	07 Dec 2021	12
A2951	Pre Amplifier	Com-Power	PAM-103	441141	25 Jan 2022	12
A2863	Pre Amplifier	Agilent	8449B	3008A02100	21 Oct 2021	12
A2893	Pre Amplifier	Schwarzbeck	BBV 9721	9721-021	28 Oct 2021	12
A490	Antenna	Teseq	CBL6111D	50859	05 Jun 2021	12
A2889	Antenna	Schwarzbeck	BBHA 9120 B	BBHA 9120B653	23 Oct 2021	12
A2890	Antenna	Schwarzbeck	HWRD 750	014	26 Oct 2021	12
A2892	Antenna	Schwarzbeck	BBHA 9170	9170-727	28 Oct 2021	12
A2916	Attenuator	AtlanTecRF	AN18W5-10	832827#1	01 Feb 2022	12
A3036	Low Pass Filter	AtlanTecRF	AFL-02000	15062902848	01 Feb 2022	12
A3083	Low Pass Filter	AtlanTecRF	AFL-01000	18010900076	03 Feb 2022	12
A2914	High Pass Filter	AtlanTecRF	AFH-03000	2155	01 Feb 2022	12
A2947	High Pass Filter	AtlanTecRF	AFH-07000	1601900001	01 Feb 2022	12
M2040	Thermohygrometer	Testo	608-H1	451224934	10 Dec 2021	12
M2044	Test Receiver	Rohde & Schwarz	ESU26	100122	03 Sep 2021	12
A3198	Magnetic Loop Antenna	ETS Lindgren	6502	00221887	01 Apr 2021	12
K0001	5m RSE Chamber	Rainford	N/A	N/A	14 Oct 2021	12



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

<b>Asset No.</b>	<b>Instrument</b>	<b>Manufacturer</b>	<b>Type No.</b>	<b>Serial No.</b>	<b>Date Calibration Due</b>	<b>Cal. Interval (Months)</b>
M2003	Thermohygrometer	Testo	608-H1	45046641	10 Dec 2021	12
K0017	3m RSE Chamber	Rainford	N/A	N/A	21 Oct 2021	12
M1995	Test Receiver	Rohde & Schwarz	ESU40	100428	07 Dec 2021	12
A2863	Pre Amplifier	Agilent	8449B	3008A02100	21 Oct 2021	12
A2889	Antenna	Schwarzbeck	BBHA 9120 B	BBHA 9120B653	23 Oct 2021	12
A2916	Attenuator	AtlanTecRF	AN18W5-10	832827#1	01 Feb 2022	12

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

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

<b>Brand Name:</b>	Buddi
<b>Model Number / HVIN:</b>	3430412
<b>PMN:</b>	Smart Tag 4
<b>Test Sample Serial Number:</b>	STS08221 <i>(Conducted sample #1)</i>
<b>Hardware Version:</b>	V11.10
<b>Software Version:</b>	1.40.8
<b>FCC ID:</b>	ZDLST5
<b>ISED Certification Number:</b>	IC 20371-ST5

<b>Brand Name:</b>	Buddi
<b>Model Number / HVIN:</b>	3430412
<b>PMN:</b>	Smart Tag 4
<b>Test Sample Serial Number:</b>	STS08422 <i>(Conducted sample #2)</i>
<b>Hardware Version:</b>	V11.10
<b>Software Version:</b>	1.40.8
<b>FCC ID:</b>	ZDLST5
<b>ISED Certification Number:</b>	IC 20371-ST5

<b>Brand Name:</b>	Buddi
<b>Model Number / HVIN:</b>	3430412
<b>PMN:</b>	Smart Tag 4
<b>Test Sample Serial Number:</b>	STS08212 <i>(Radiated sample #1)</i>
<b>Hardware Version:</b>	V11.10
<b>Software Version:</b>	1.40.8
<b>FCC ID:</b>	ZDLST5
<b>ISED Certification Number:</b>	IC 20371-ST5

#### **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	
Channel Spacing:	20 MHz		
Transmit Frequency Range:	2400 MHz to 2483.5 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 WLAN radio module contains a integral 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:

<b>Brand Name:</b>	Smart Tag Strap
<b>Description:</b>	Strap which fits around the subject's ankle and then clicks in either end to the Smart Tag device
<b>Model Name or Number:</b>	Smart Tag Strap
<b>Serial Number:</b>	3470000-6

<b>Brand Name:</b>	Smart Tag Strap
<b>Description:</b>	Strap which fits around the subject's ankle and then clicks in either end to the Smart Tag device
<b>Model Name or Number:</b>	Smart Tag Strap
<b>Serial Number:</b>	3470000-9

<b>Brand Name:</b>	Smart Tag Strap
<b>Description:</b>	Switching Power Adaptor
<b>Model Name or Number:</b>	DSA-15P-12
<b>Serial Number:</b>	T4641RW

#### **Operating Modes**

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

- Continuously transmitting with a modulated carrier at maximum power on the bottom and top channels as required.

#### **Configuration and Peripherals**

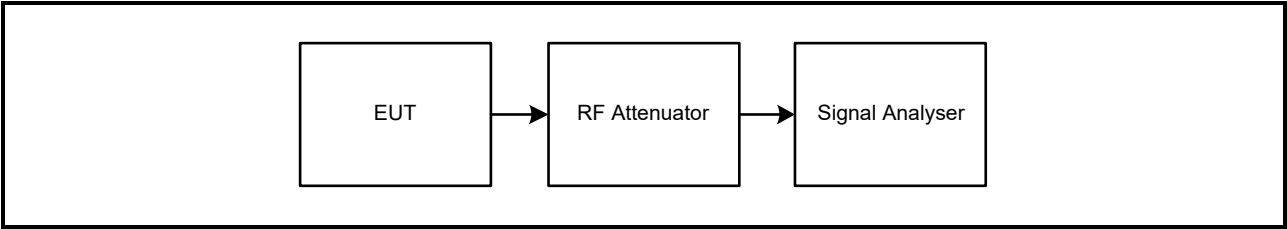
The EUT was tested in the following configuration(s):

- The EUT was controlled in test mode using a Smart TAG Base Unit supplied by the customer. The Smart Tag Base Unit was coupled to the EUT and a predetermined number of user configurable modes were selected by pressing the red button on the Smart TAG Base Unit. The Smart TAG Base Unit was used to enable continuous transmission and to select the test channels as required. The customer supplied a document containing the setup instructions 'SmartTAG 3G+WIFI v11.10 - WLAN TX Performance FCC Test Guide.pdf.
- The customer declared the following data rates to be used for all measurements:
  - 802.11b – 1 Mbps
  - 802.11g – 6 Mbps
  - 802.11n – MCS0
- Transmitter radiated spurious emissions tests were performed with the ankle strap fitted to the EUT and powered from the internal battery.
- All radiated tests were performed with the EUT placed in the worst case orientation/position for the applicable test.
- The customer supplied a U.FL RF cable with the EUT in order to perform conducted measurements. The measured additional path loss was included in any path loss calculations.

**Test Setup Diagrams**

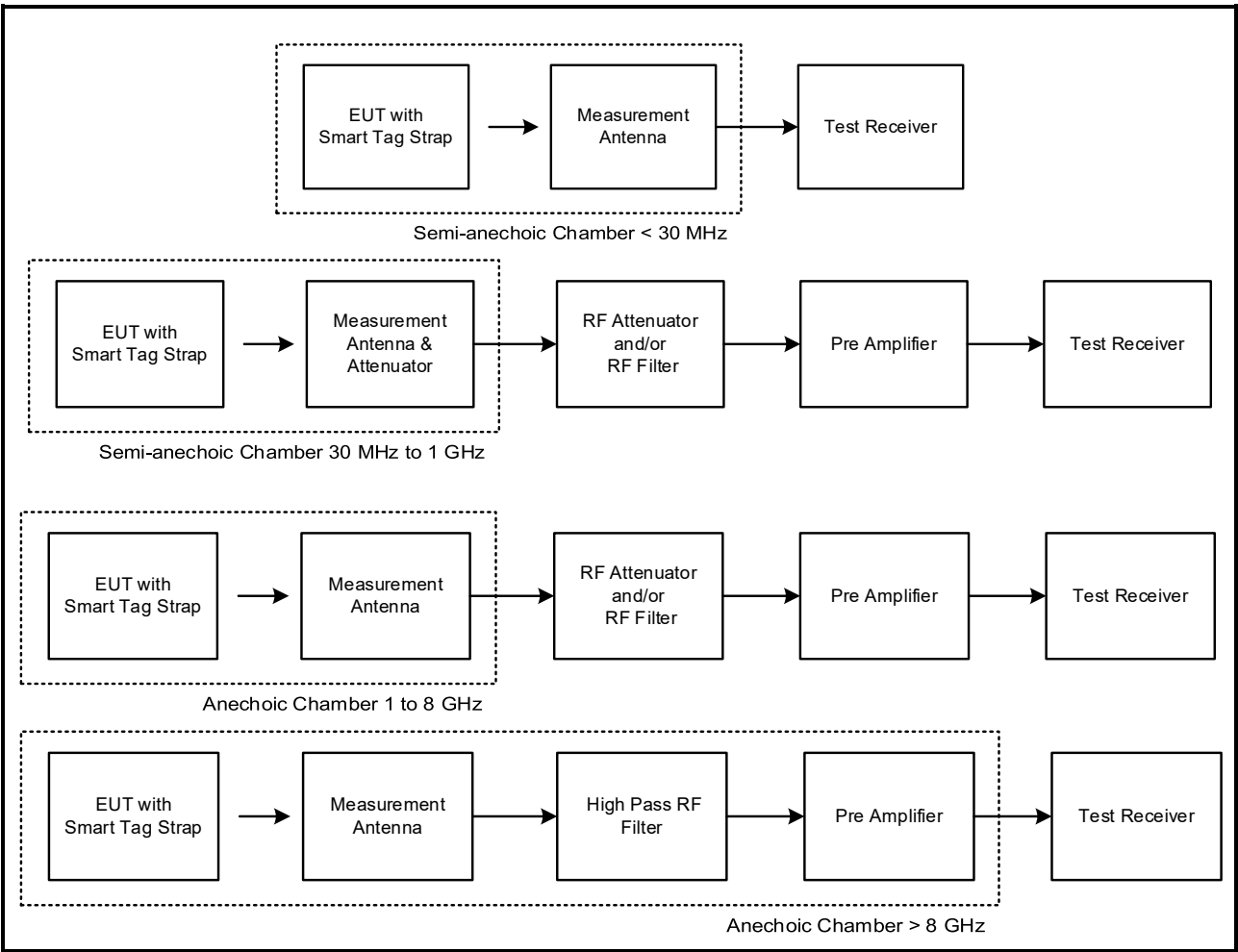
**Conducted Tests:**

**Test Setup for Transmitter Conducted Tests**



**Radiated Tests:**

**Test Setup for Transmitter Radiated Emissions**



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

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

#### **Test Summary:**

<b>Test Engineers:</b>	Matthew Botfield	<b>Test Date:</b>	23 March 2021
<b>Test Sample Serial Number:</b>	STS08422		

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

#### **Environmental Conditions:**

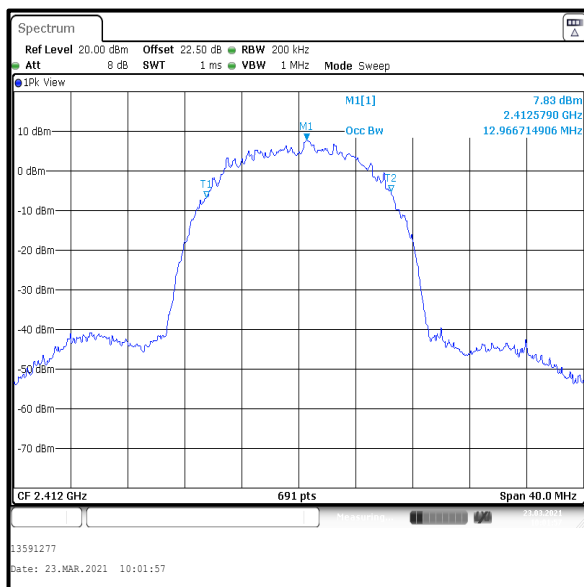
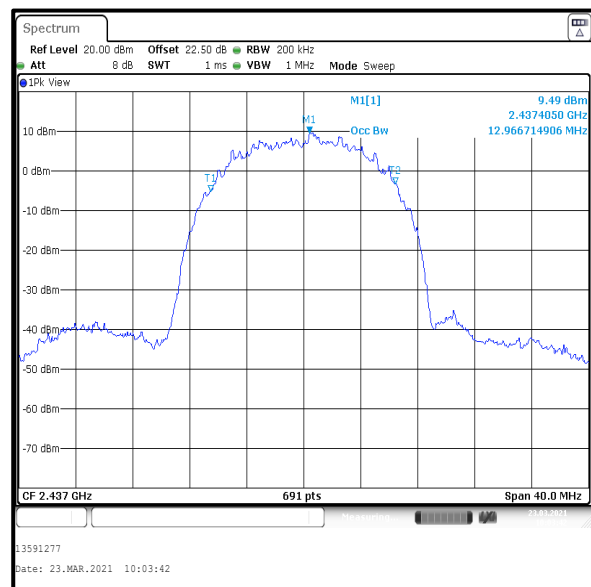
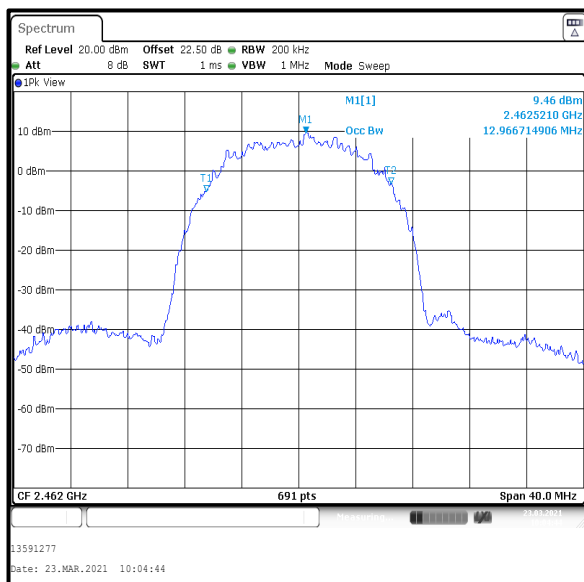
<b>Temperature (°C):</b>	21
<b>Relative Humidity (%):</b>	39

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

1. The 99% emission bandwidth was measured using the signal analyser occupied bandwidth function. The resolution bandwidth was set in the range of 1% to 5% of the occupied bandwidth and the video bandwidth set to 3 times the resolution bandwidth as the signal analyser allowed without being below 3 times RBW. The span was set to capture all products of the modulation process including emission skirts.
2. The signal analyser resolution bandwidth was set to 200 kHz and video bandwidth 1 MHz. A peak detector was used, sweep time was set to auto and the trace mode was Max Hold. The span was set to 40 MHz. The signal analyser function set the measurements to be made at 99% of the emission bandwidth. The results are given in the tables below.
3. 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.

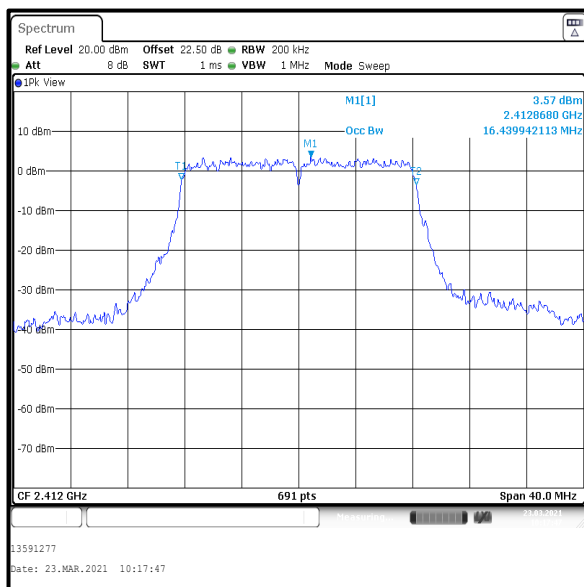
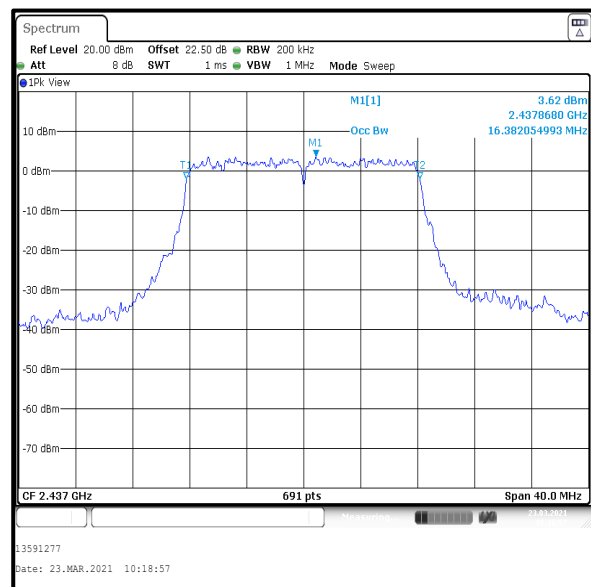
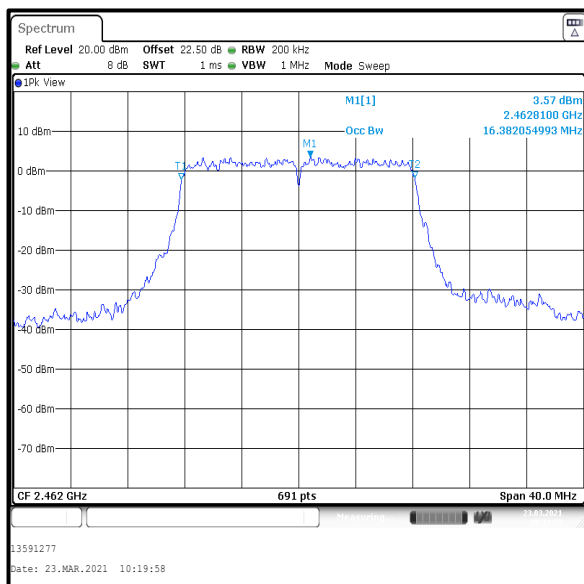
**Transmitter 99% Emission Bandwidth (continued)****Results: 802.11b / 20 MHz / DBPSK / 1 Mbps**

Channel	99% Emission Bandwidth (MHz)
Bottom	12.967
Middle	12.967
Top	12.967

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

**Transmitter 99% Emission Bandwidth (continued)****Results: 802.11g / 20 MHz / BPSK / 6 Mbps**

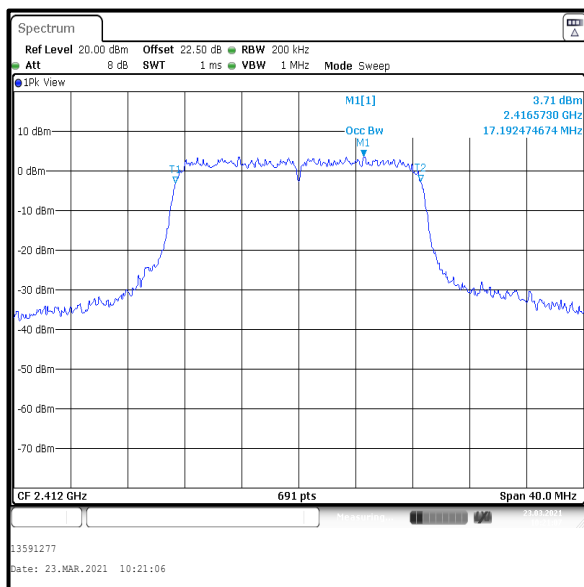
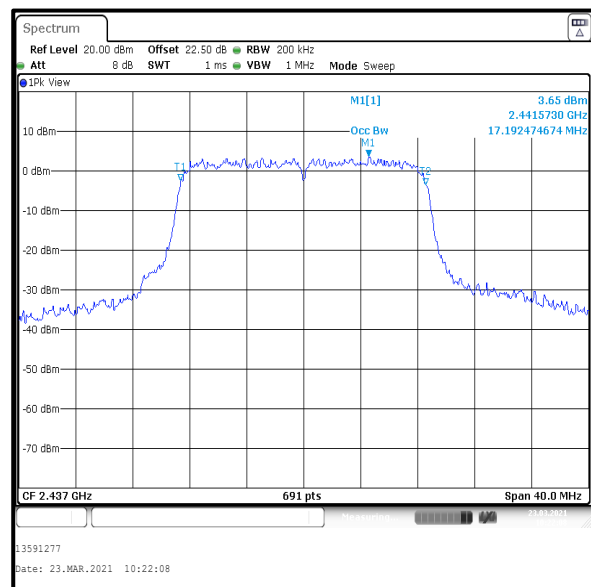
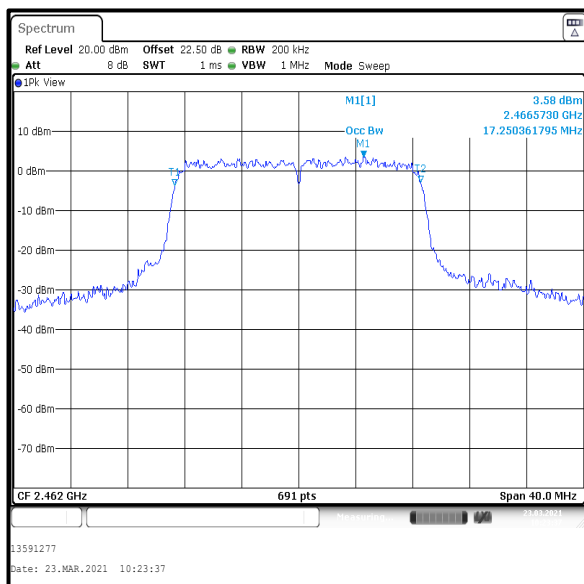
Channel	99% Emission Bandwidth (MHz)
Bottom	16.440
Middle	16.382
Top	16.382

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



**Transmitter 99% Emission Bandwidth (continued)****Results: 802.11n / HT20 / BPSK / MCS0**

Channel	99% Emission Bandwidth (MHz)
Bottom	17.192
Middle	17.192
Top	17.250

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

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

### **Test Summary:**

<b>Test Engineer:</b>	Matthew Botfield	<b>Test Date:</b>	26 February 2021
<b>Test Sample Serial Number:</b>	STS08221		

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

### **Environmental Conditions:**

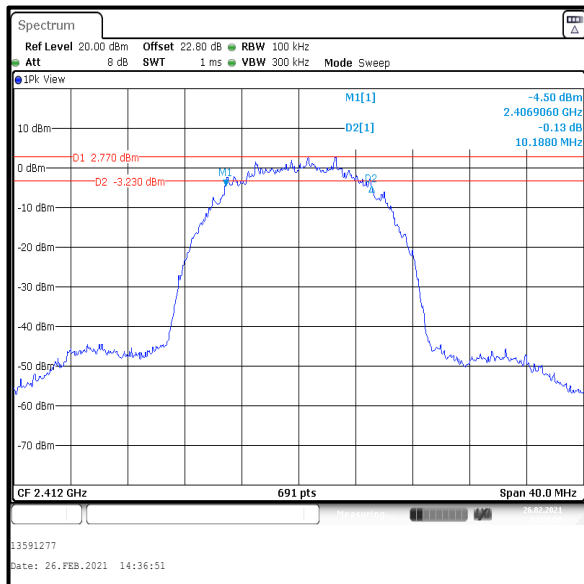
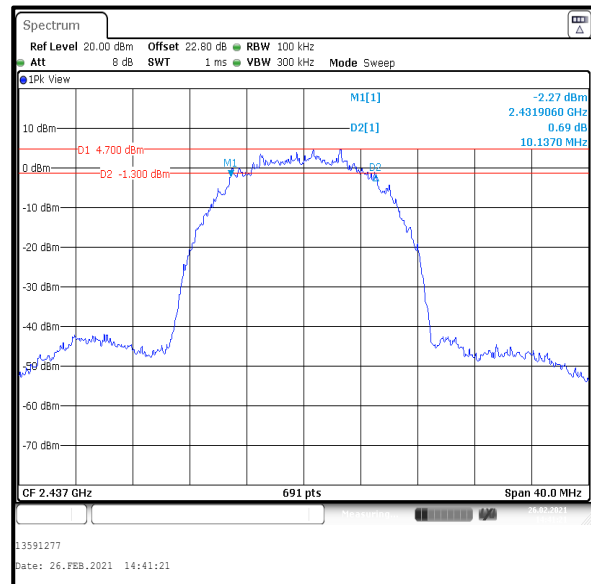
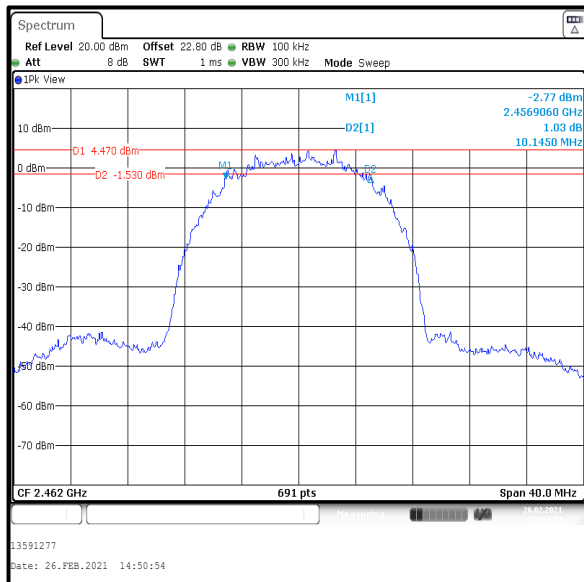
<b>Temperature (°C):</b>	23
<b>Relative Humidity (%):</b>	37

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

1. The customer declared the following data rates to be used for all measurements:
  - 802.11b – DBPSK / 1 Mbps
  - 802.11g – BPSK / 6 Mbps
  - 802.11n HT20 – BPSK / MCS0
2. 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
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.

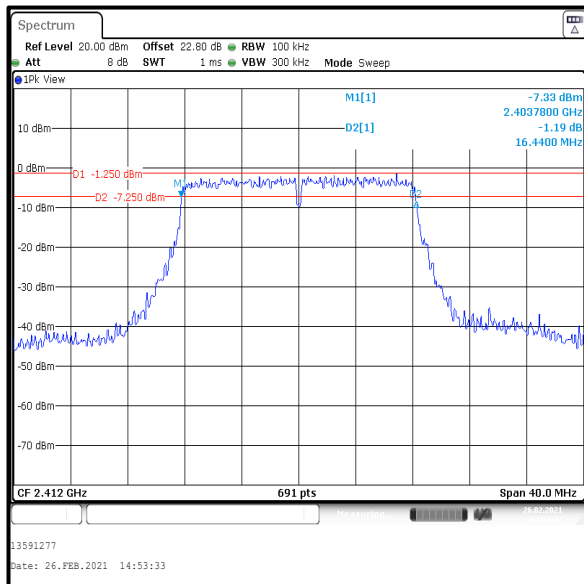
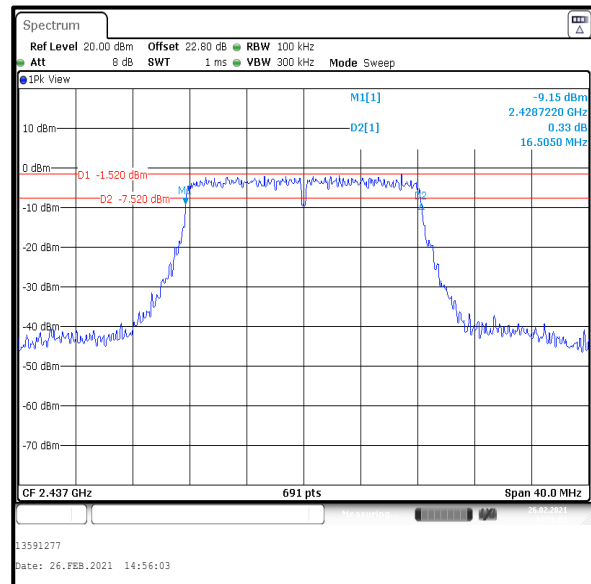
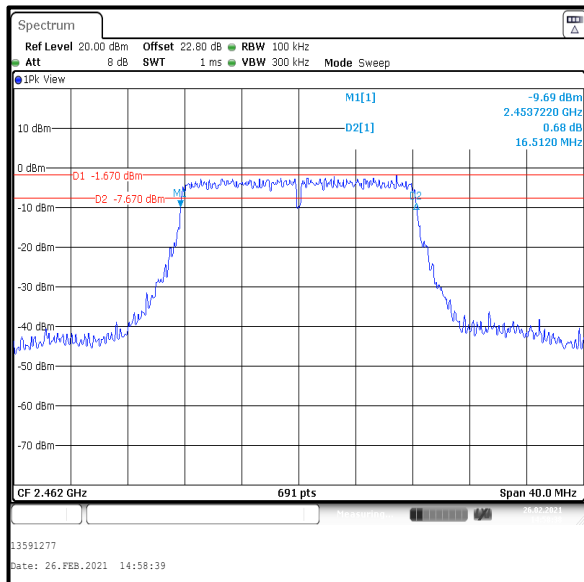
**Transmitter Minimum 6 dB Bandwidth (continued)****Results: 802.11b / 20 MHz / DBPSK / 1 Mbps**

Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
Bottom	10188	≥500	9688	Complied
Middle	10137	≥500	9637	Complied
Top	10145	≥500	9645	Complied

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

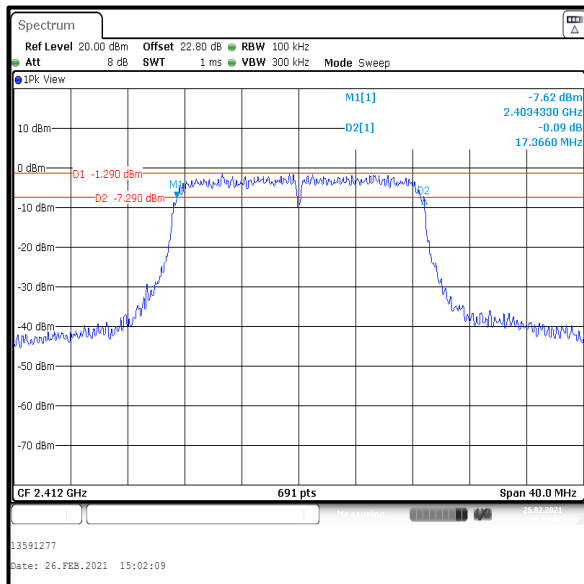
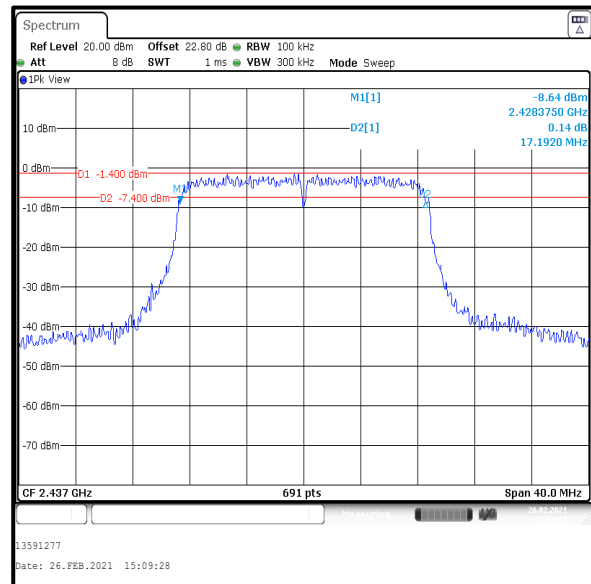
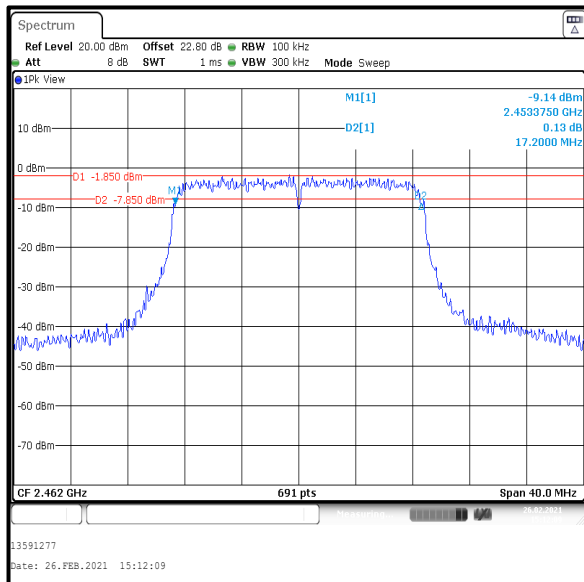
**Transmitter Minimum 6 dB Bandwidth (continued)****Results: 802.11g / 20 MHz / BPSK / 6 Mbps**

Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
Bottom	16440	≥500	15940	Complied
Middle	16505	≥500	16005	Complied
Top	16512	≥500	16012	Complied

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

**Transmitter Minimum 6 dB Bandwidth (continued)****Results: 802.11n / HT20 / BPSK / MCS0**

Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
Bottom	17366	≥500	16866	Complied
Middle	17192	≥500	16692	Complied
Top	17200	≥500	16700	Complied

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

### **4.3. Transmitter Power Spectral Density**

#### **Test Summary:**

<b>Test Engineer:</b>	Chanthu Thevarajah	<b>Test Date:</b>	19 March 2021
<b>Test Sample Serial Number:</b>	STS08422		

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

#### **Environmental Conditions:**

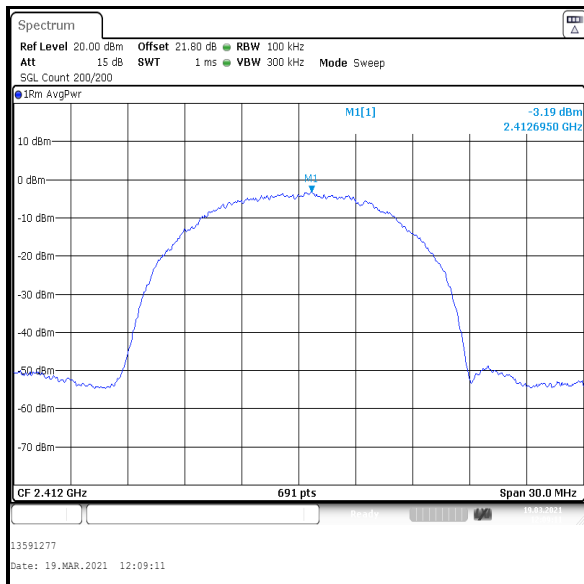
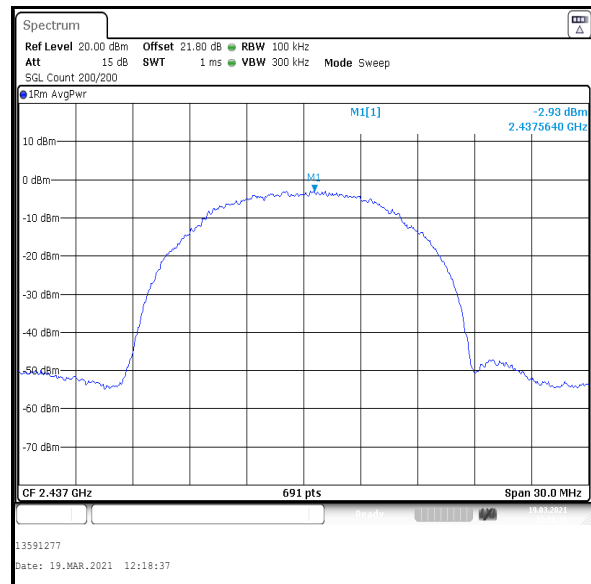
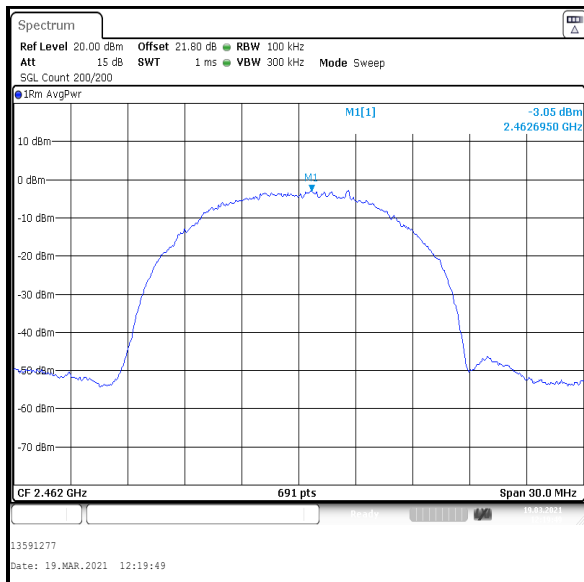
<b>Temperature (°C):</b>	22
<b>Relative Humidity (%):</b>	36

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

1. The customer declared the following data rates to be used for all measurements:
  - 802.11b / DBPSK / 1 Mbps
  - 802.11g / BPSK / 6 Mbps
  - 802.11n HT20 / BPSK / MCS0
2. Final measurements were performed using the above configurations on bottom, middle and top channels.
3. The EUT was transmitting at 100% duty cycle and testing was performed in accordance with ANSI C63.10 Section 11.10.3 Method AVGPDS-1. The signal analyser resolution bandwidth was set to 100 kHz and video bandwidth 300 kHz. An RMS detector was used and sweep time set manually to perform trace averaging over 200 traces. The span was set greater than 1.5 times the 99% emission bandwidth. The highest peak of the measured signal was recorded.
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.

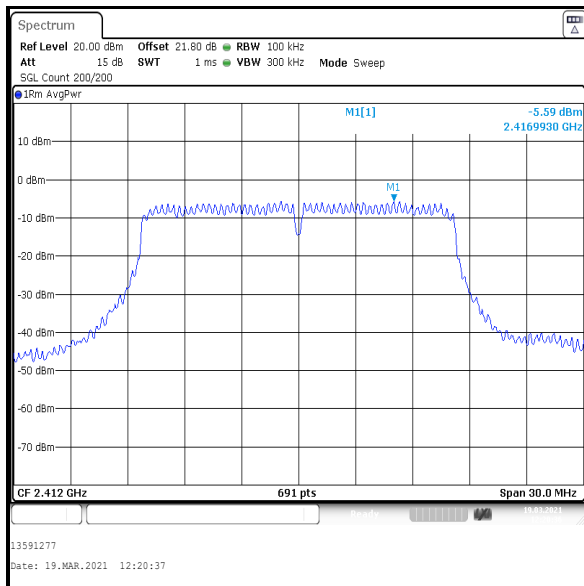
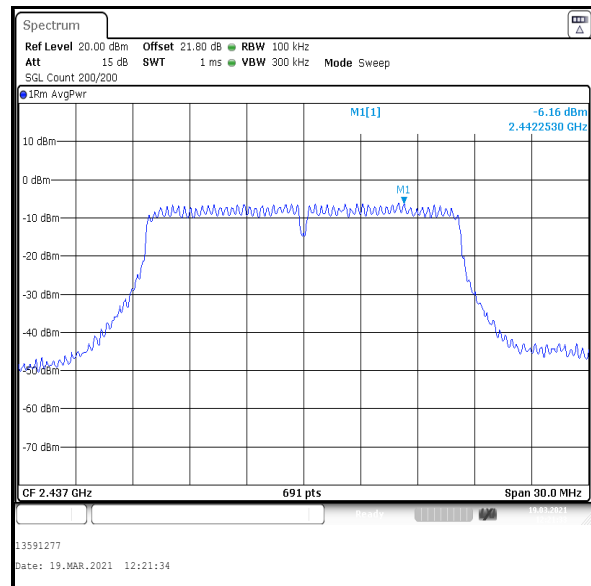
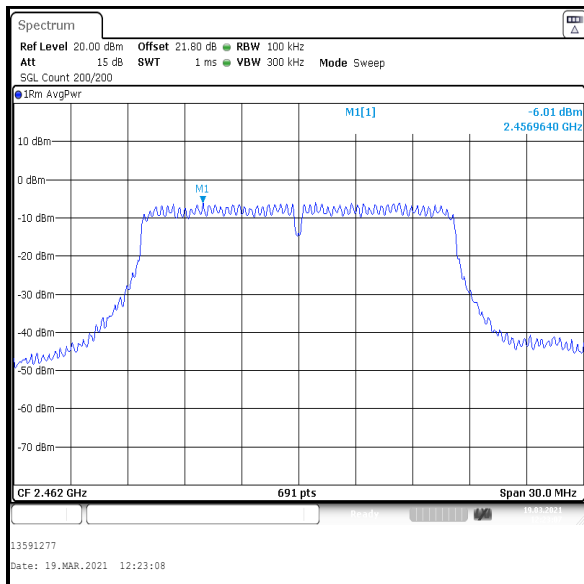
**Transmitter Power Spectral Density (continued)****Results: 802.11b / 20 MHz / DBPSK / 1 Mbps**

Channel	PSD (dBm/100 kHz)	Limit (dBm/3 kHz)	Margin (dB)	Result
Bottom	-3.2	8.0	11.2	Complied
Middle	-2.9	8.0	10.9	Complied
Top	-3.0	8.0	11.0	Complied

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

**Transmitter Power Spectral Density (continued)****Results: 802.11g / 20 MHz / BPSK / 6 Mbps**

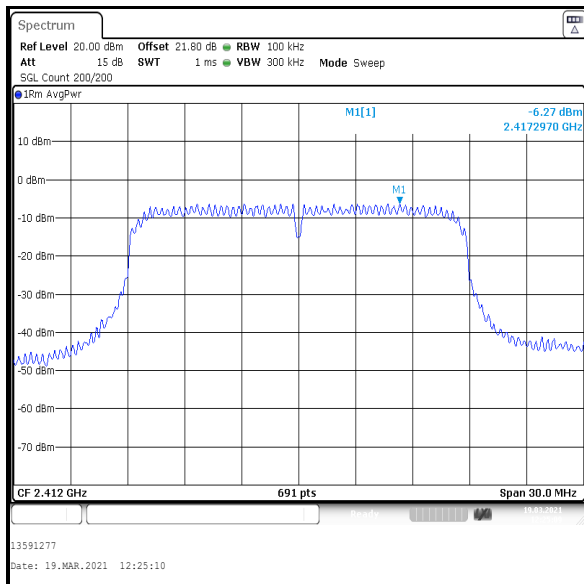
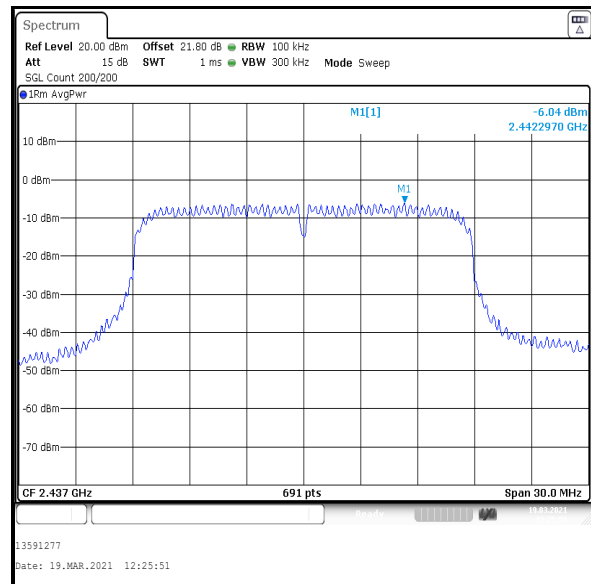
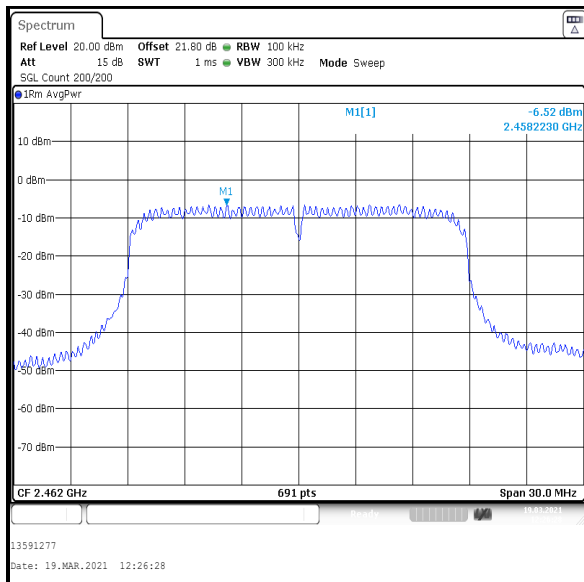
Channel	PSD (dBm/100 kHz)	Limit (dBm/3 kHz)	Margin (dB)	Result
Bottom	-5.6	8.0	13.6	Complied
Middle	-6.2	8.0	14.2	Complied
Top	-6.0	8.0	14.0	Complied

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



**Transmitter Power Spectral Density (continued)****Results: 802.11n / HT20 / BPSK / MCS0**

Channel	PSD (dBm/100 kHz)	Limit (dBm/3 kHz)	Margin (dB)	Result
Bottom	-6.3	8.0	14.3	Complied
Middle	-6.0	8.0	14.0	Complied
Top	-6.5	8.0	14.5	Complied

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

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

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

<b>Test Engineer:</b>	Matthew Botfield	<b>Test Date:</b>	23 March 2021
<b>Test Sample Serial Number:</b>	STS08422		

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

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

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

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

1. The customer declared the following data rates to be used for all measurements:
  - 802.11b / DBPSK / 1 Mbps
  - 802.11g / BPSK / 6 Mbps
  - 802.11n HT20 / BPSK / MCS0
2. Final measurements were performed using the above configurations on bottom, middle and top channels.
3. The EUT was transmitting at 100% duty cycle and testing was performed in accordance with ANSI C63.10 Section 11.9.2.2.2 Method AVGSA-1. The signal analyser's integration function was used to integrate across the 99% occupied bandwidth. The signal analyser resolution bandwidth was set to 200 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.
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 Maximum (Average) Output Power (continued)****Results: 802.11b / 20 MHz / DBPSK / 1 Mbps****Conducted Peak Limit Comparison**

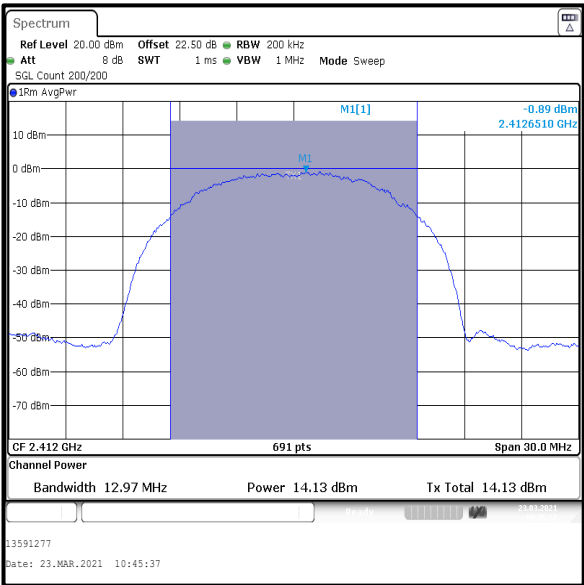
Channel	Conducted Power (dBm)	Conducted Power Limit (dBm)	Margin (dB)	Result
Bottom	14.1	30.0	15.9	Complied
Middle	14.8	30.0	15.2	Complied
Top	14.9	30.0	15.1	Complied

**EIRP Limit Comparison**

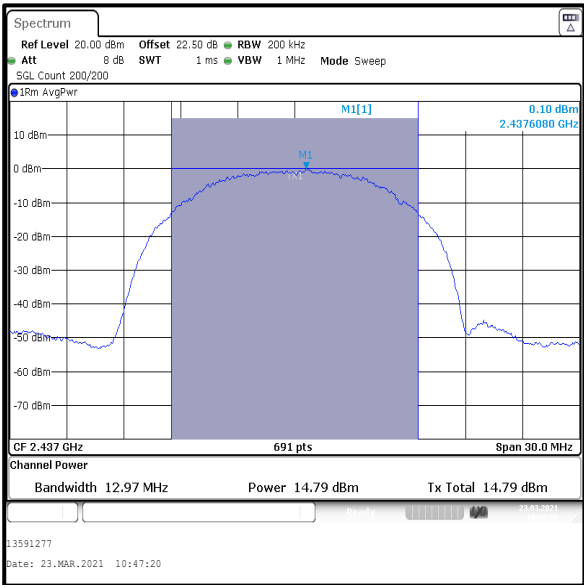
Channel	Conducted Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
Bottom	14.1	-1.5	12.6	36.0	23.4	Complied
Middle	14.8	-1.5	13.3	36.0	22.7	Complied
Top	14.9	-1.5	13.4	36.0	22.6	Complied

Transmitter Maximum (Average) Output Power (continued)

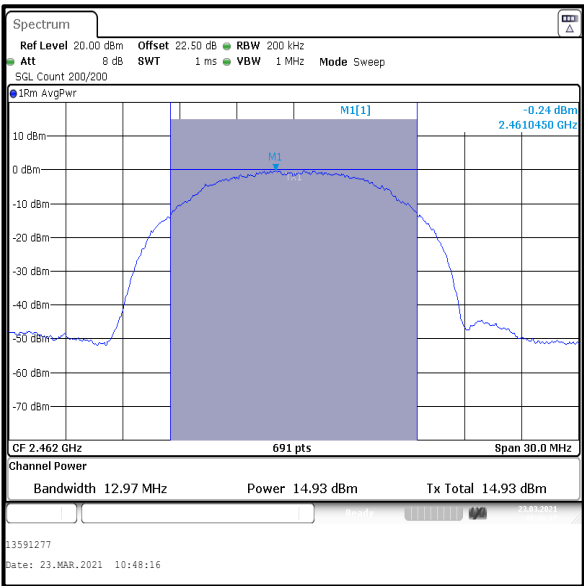
Results: 802.11b / 20 MHz / DBPSK / 1 Mbps



Bottom Channel



Middle Channel



Top Channel

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

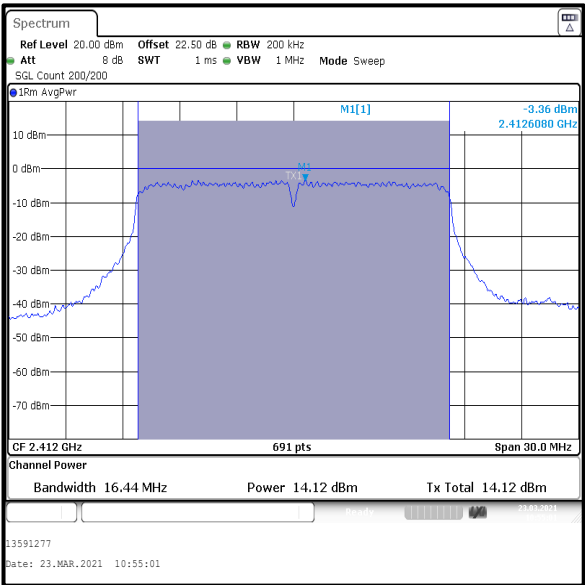
Channel	Conducted Power (dBm)	Conducted Power Limit (dBm)	Margin (dB)	Result
Bottom	14.1	30.0	15.9	Complied
Middle	13.8	30.0	16.2	Complied
Top	13.8	30.0	16.2	Complied

**EIRP Limit Comparison**

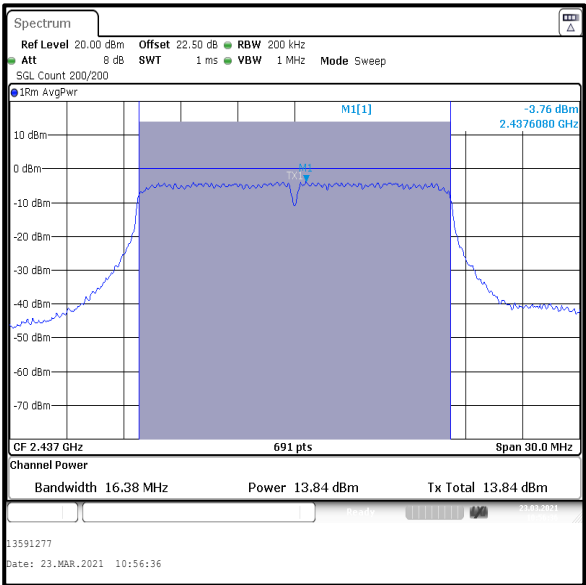
Channel	Conducted Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
Bottom	14.1	-1.5	12.6	36.0	23.4	Complied
Middle	13.8	-1.5	12.3	36.0	23.7	Complied
Top	13.8	-1.5	12.3	36.0	23.7	Complied

Transmitter Maximum (Average) Output Power (continued)

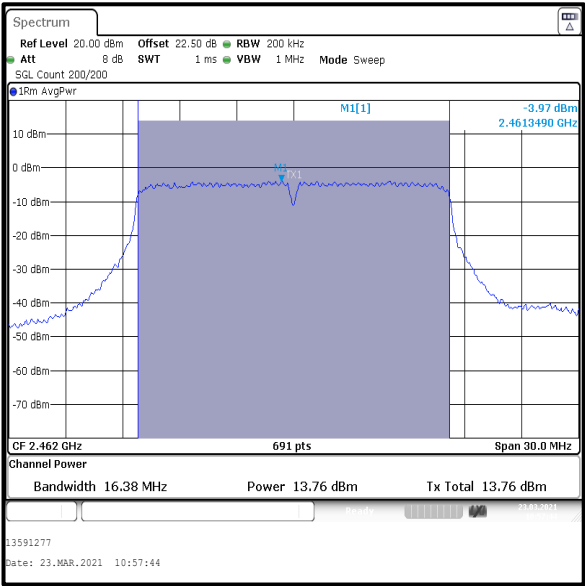
Results: 802.11g / 20 MHz / BPSK / 6 Mbps



Bottom Channel



Middle Channel



Top Channel

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

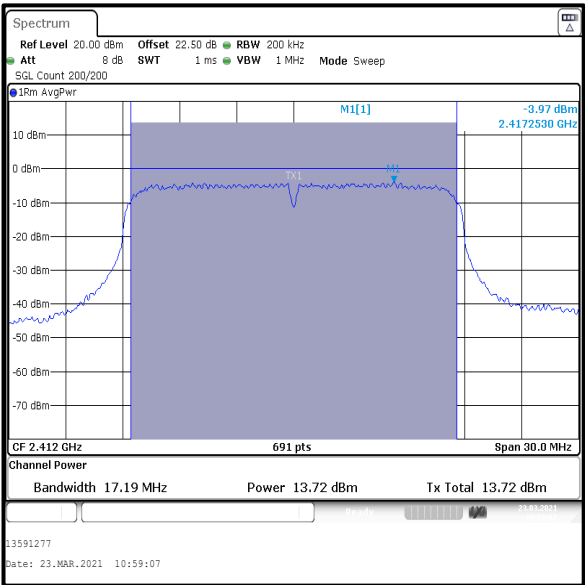
Channel	Conducted Power (dBm)	Conducted Power Limit (dBm)	Margin (dB)	Result
Bottom	13.7	30.0	16.3	Complied
Middle	13.7	30.0	16.3	Complied
Top	13.6	30.0	16.4	Complied

**EIRP Limit Comparison**

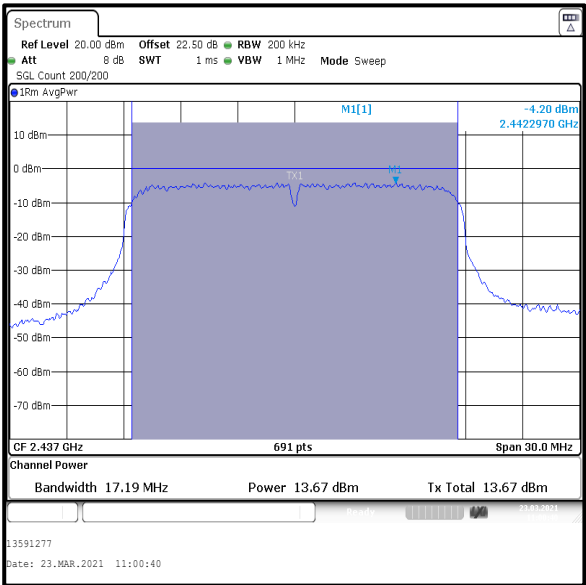
Channel	Conducted Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
Bottom	13.7	-1.5	12.2	36.0	23.8	Complied
Middle	13.7	-1.5	12.2	36.0	23.8	Complied
Top	13.6	-1.5	12.1	36.0	23.9	Complied

Transmitter Maximum (Average) Output Power (continued)

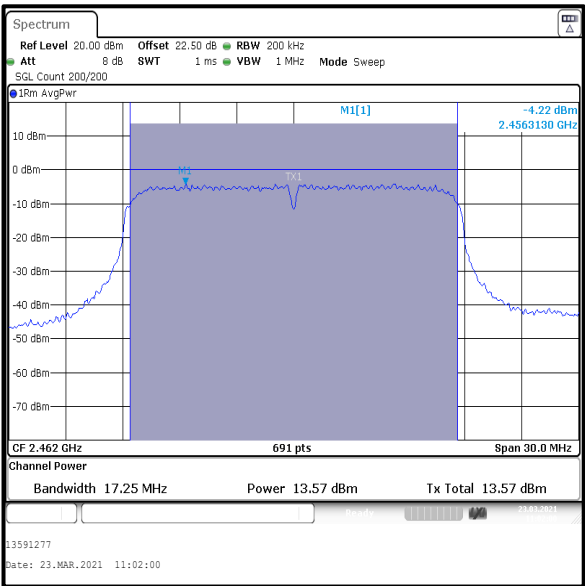
Results: 802.11n / HT20 / BPSK / MCS0



Bottom Channel



Middle Channel



Top Channel



## **5. Radiated Test Results**

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

#### **Test Summary:**

<b>Test Engineers:</b>	Tom Sleigh & Mohamed Toubella	<b>Test Dates:</b>	09 February 2021 & 20 March 2021
<b>Test Sample Serial Number:</b>	STS08212		

<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, 6.4 and 6.5
<b>Frequency Range</b>	9 kHz to 1000 MHz

#### **Environmental Conditions:**

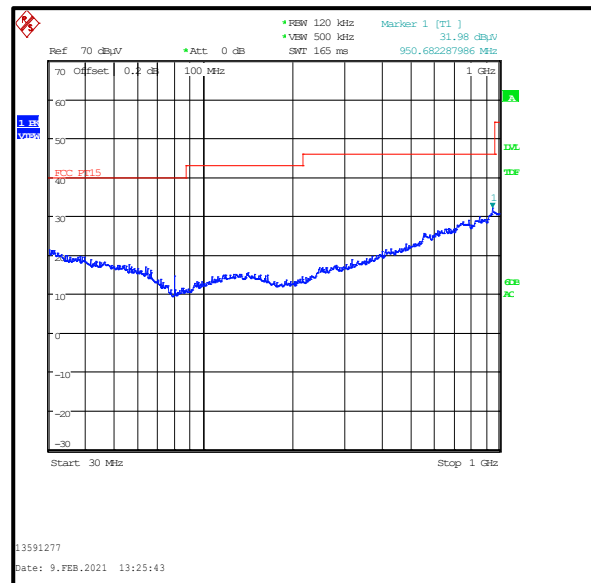
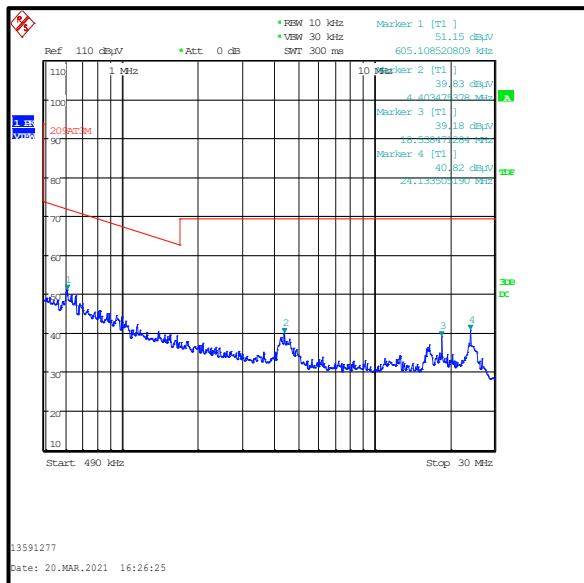
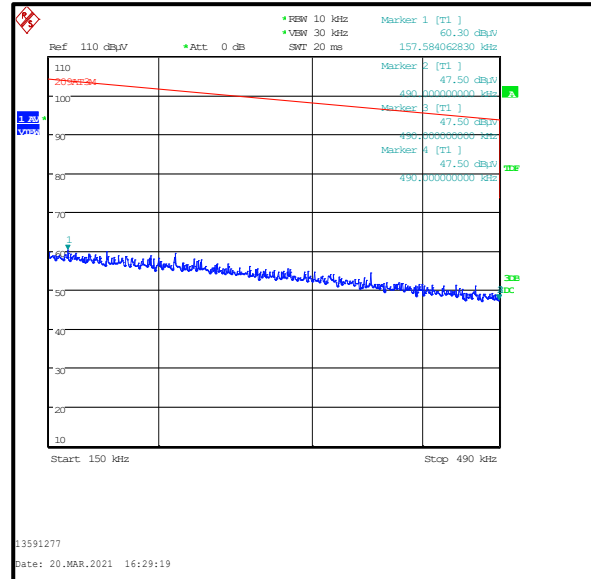
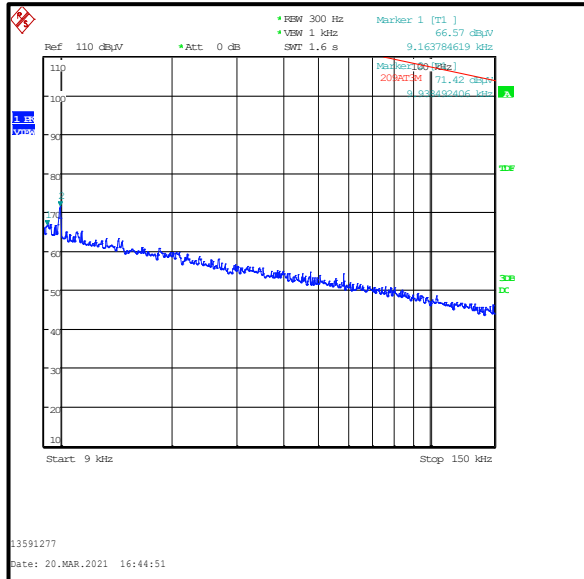
<b>Temperature (°C):</b>	23 to 24
<b>Relative Humidity (%):</b>	25 to 26

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

1. The EUT was transmitting with a data rate of 802.11n / MCS0 as it was found to have the highest power and therefore deemed worst case.
2. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
3. 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.
4. All emissions shown on the pre-scans were investigated and found to be ambient, or > 20 dB below the appropriate limit or below the noise floor of the measurement system. Therefore the highest peak noise floor reading of the measuring receiver was recorded in the table below.
5. 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.
6. There are ambient emissions between 4 MHz to 30 MHz on the pre-scan plot for 490 kHz to 30 MHz performed in semi-anechoic chamber. A background scan between 490 kHz to 30 MHz is stored on the company IT server and is available for inspection upon request.
7. 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.
8. 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 490 kHz, the resolution bandwidth was set to 10 kHz and video bandwidth 30 kHz. An average detector was used and trace mode was Max Hold. For 490 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 / 802.11n / HT20 / MCS0**

Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
950.682	Vertical	32.0	46.0	14.0	Complied



## 5.2. Transmitter Radiated Emissions >1 GHz

### Test Summary:

Test Engineer:	Tom Sleight	Test Dates:	09 February 2021 & 10 February 2021
Test Sample Serial Number:	STS08212		

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
Frequency Range	1 GHz to 25 GHz

### Environmental Conditions:

Temperature (°C):	23 to 24
Relative Humidity (%):	25 to 26

### Note(s):

1. The EUT was transmitting with a data rate of 802.11n / MCS0 as it was found to have the highest power and therefore deemed worst case.
2. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
3. All other emissions shown on the pre-scan plot were investigated and found to be ambient or >20 dB below the appropriate limit or below the measurement system noise floor.
4. The emission shown approximately at 2437 MHz on the 1 GHz to 3 GHz plot is the EUT fundamental.
5. Pre-scans and final measurements above 1 GHz were performed in a fully anechoic chamber (Asset Number K0017) 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. During prescans, 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 with the EUT placed at a height of 1.5 metres 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.

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

Frequency (MHz)	Antenna Polarity	Peak Level (dB $\mu$ V/m)	Peak Limit (dB $\mu$ V/m)	Margin (dB)	Result
4821.756	Vertical	63.4	74.0	10.6	Complied

**Results: Bottom Channel / Average**

Frequency (MHz)	Antenna Polarity	Average Level (dB $\mu$ V/m)	Average Limit (dB $\mu$ V/m)	Margin (dB)	Result
4821.436	Vertical	50.8	54.0	3.2	Complied

**Results: Middle Channel / Peak**

Frequency (MHz)	Antenna Polarity	Peak Level (dB $\mu$ V/m)	Peak Limit (dB $\mu$ V/m)	Margin (dB)	Result
4871.936	Vertical	61.9	74.0	12.1	Complied

**Results: Middle Channel / Average**

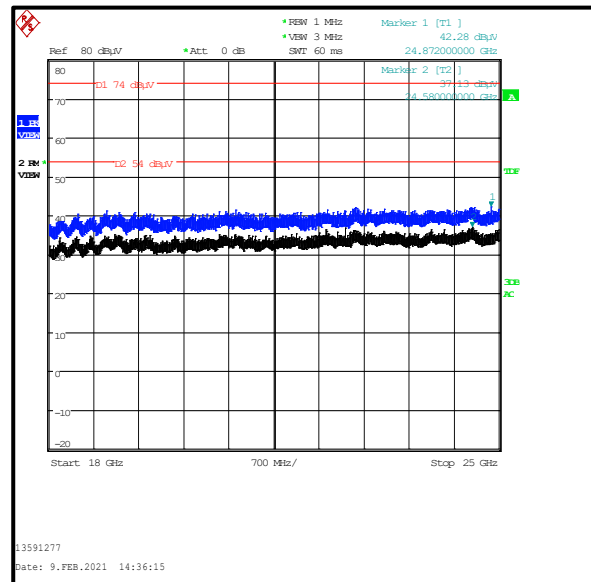
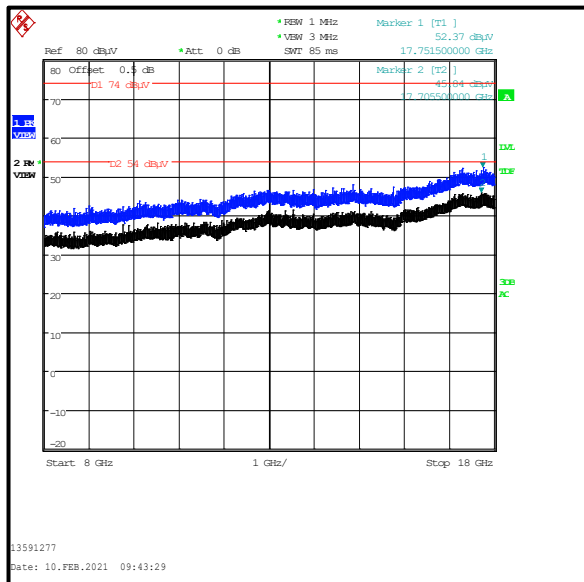
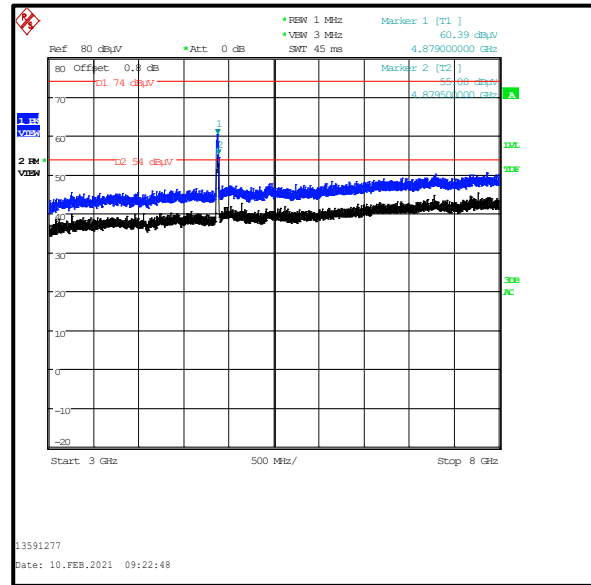
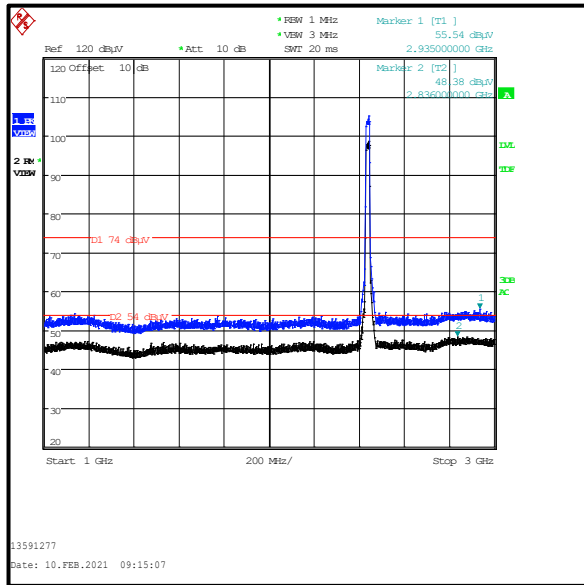
Frequency (MHz)	Antenna Polarity	Average Level (dB $\mu$ V/m)	Average Limit (dB $\mu$ V/m)	Margin (dB)	Result
4871.054	Vertical	49.3	54.0	4.7	Complied

**Results: Top Channel / Peak**

Frequency (MHz)	Antenna Polarity	Peak Level (dB $\mu$ V/m)	Peak Limit (dB $\mu$ V/m)	Margin (dB)	Result
4921.837	Vertical	59.4	74.0	14.6	Complied

**Results: Top Channel / Average**

Frequency (MHz)	Antenna Polarity	Average Level (dB $\mu$ V/m)	Average Limit (dB $\mu$ V/m)	Margin (dB)	Result
4927.526	Vertical	47.4	54.0	6.6	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:

Test Engineer:	Tom Sleigh	Test Dates:	08 February 2021 to 11 February 2021
Test Sample Serial Number:	STS08212		

FCC Reference:	Parts 15.247(d) & 15.209(a)
ISED Canada Reference:	RSS-Gen 6.13 / 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):	23 to 24
Relative Humidity (%):	25 to 26

#### Note(s):

1. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
2. 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 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.
3. 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.
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.

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

Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	-30 dBc Limit (dB $\mu$ V/m)	Margin (dB)	Result
2398.157	Vertical	49.1	68.4	19.3	Complied
2400	Vertical	45.9	68.4	22.5	Complied

**Results: Upper Band Edge / Peak**

Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2483.5	Vertical	54.6	74.0	19.4	Complied
2502.170	Vertical	55.1	74.0	18.9	Complied

**Results: Upper Band Edge / Average**

Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2483.5	Vertical	43.6	54.0	10.4	Complied

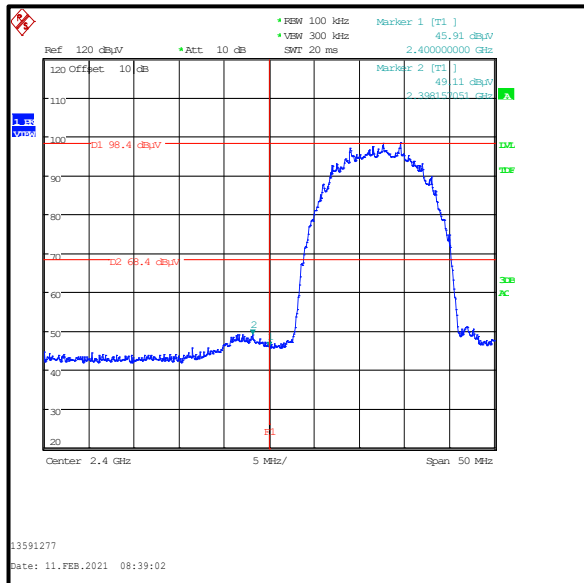
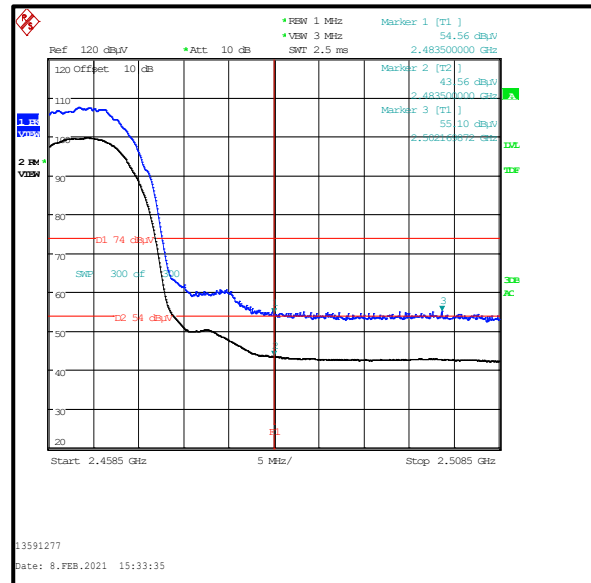
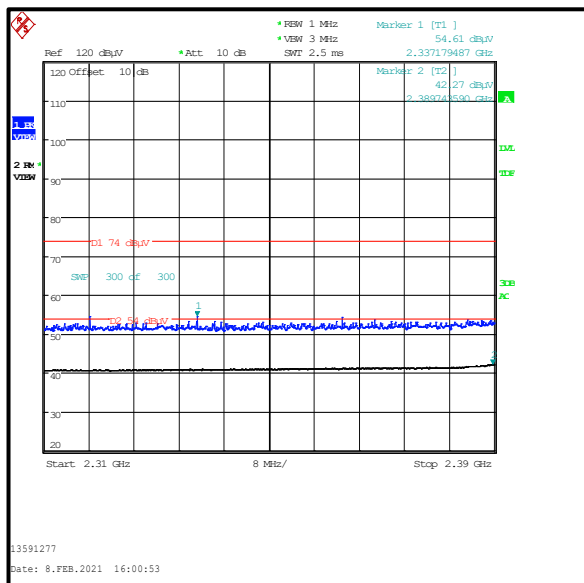
**Results: 2310 MHz to 2390 MHz Restricted Band / Peak**

Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2337.179	Vertical	54.6	74.0	19.4	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
2389.744	Vertical	42.3	54.0	11.7	Complied



**Transmitter Band Edge Radiated Emissions (continued)****Results: 802.11b / 20 MHz / BPSK / 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 $\mu$ V/m)	-30 dBc Limit (dB $\mu$ V/m)	Margin (dB)	Result
2400	Vertical	56.2	64.3	8.1	Complied

**Results: Upper Band Edge / Peak**

Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2483.5	Vertical	63.3	74.0	10.7	Complied
2483.660	Vertical	63.7	74.0	10.3	Complied

**Results: Upper Band Edge / Average**

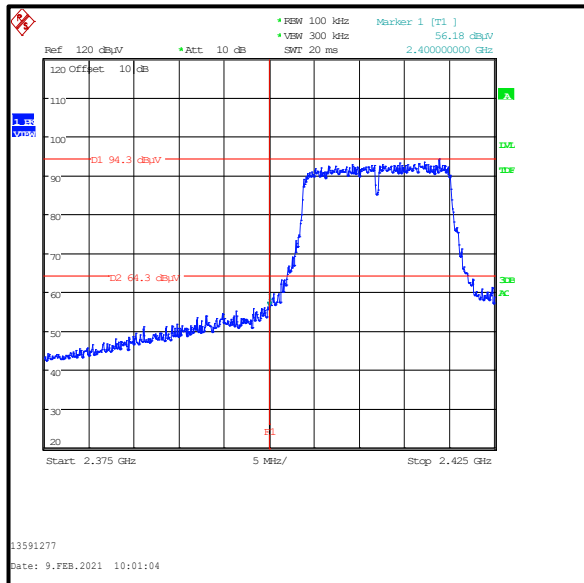
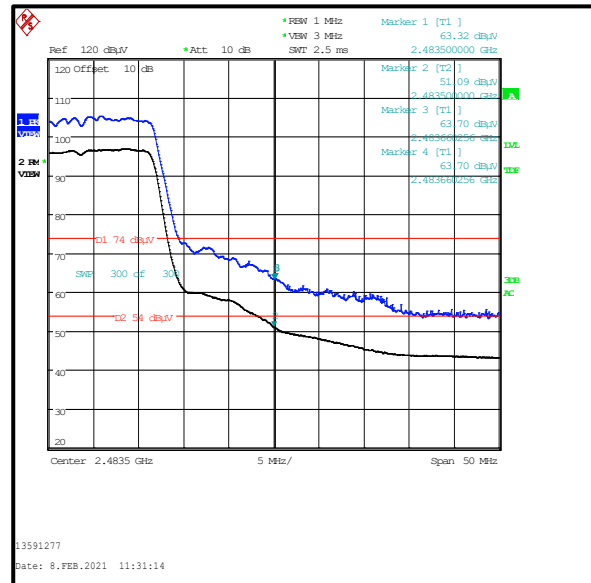
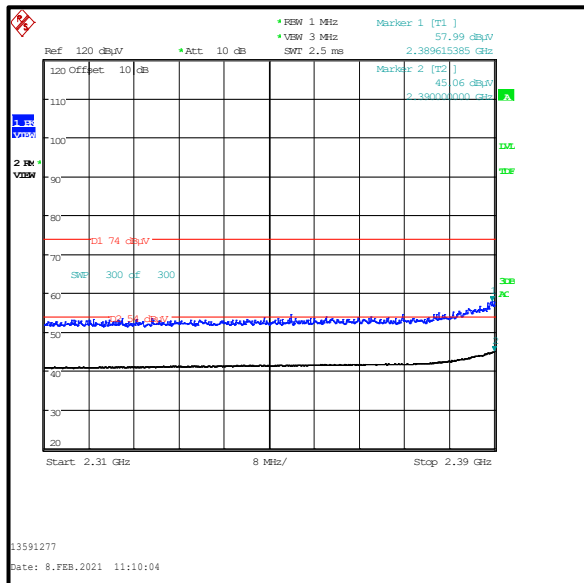
Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2483.5	Vertical	51.1	54.0	2.9	Complied

**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	Vertical	58.0	74.0	16.0	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	Vertical	45.1	54.0	8.9	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 $\mu$ V/m)	-30 dBc Limit (dB $\mu$ V/m)	Margin (dB)	Result
2399.840	Vertical	56.2	63.2	7.0	Complied
2400	Vertical	53.8	63.2	9.4	Complied

**Results: Upper Band Edge / Peak**

Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2483.5	Vertical	64.0	74.0	10.0	Complied

**Results: Upper Band Edge / Average**

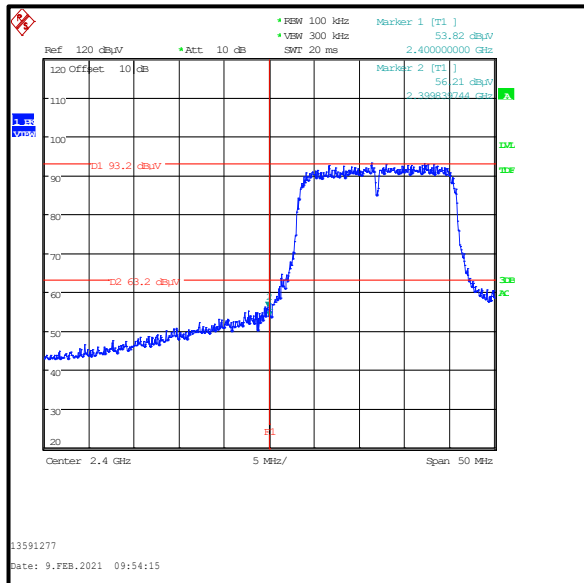
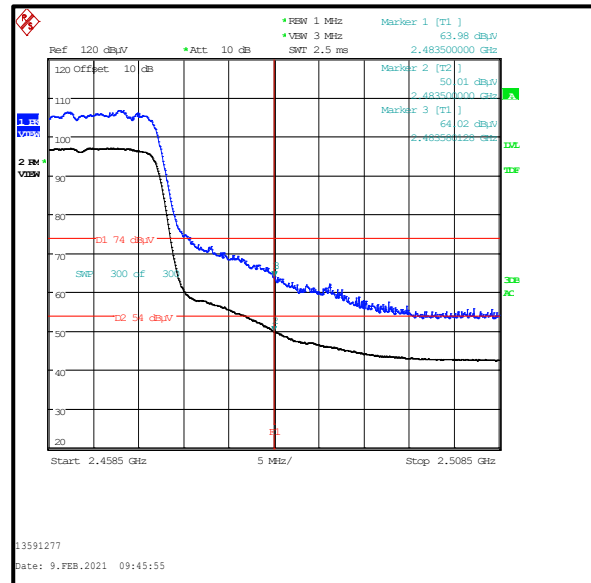
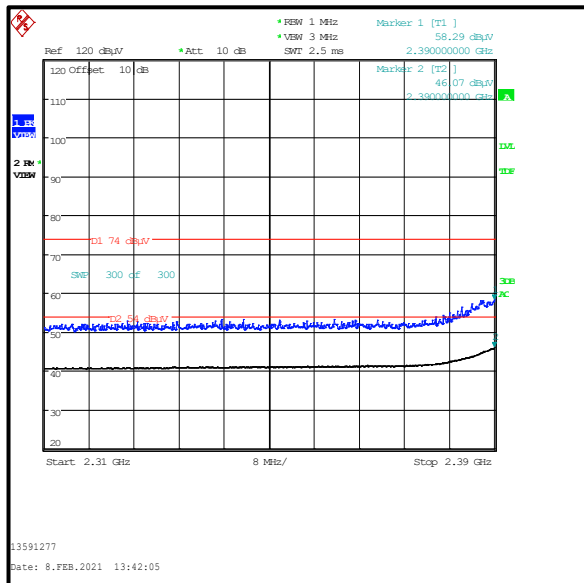
Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2483.5	Vertical	50.0	54.0	4.0	Complied

**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	Vertical	58.3	74.0	15.7	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	Vertical	46.1	54.0	7.9	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****--- END OF REPORT ---**