


# TEST REPORT

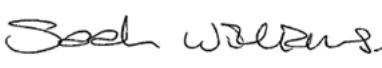
**Test Report No. : UL-RPT-RP14705831-1016A**

**Customer** : Raspberry Pi LTD  
**Model No. / HVIN** : V2.0  
**PMN** : Raspberry Pi 5  
**FCC ID** : 2ABCB-RPI5  
**ISED Certification No.** : IC: 20953-RPI5  
**Technology** : *Bluetooth* – Low Energy  
**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

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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:** 17 October 2023

**Checked by:**   
Ben Mercer  
Lead Project Engineer, Radio Laboratory

**Company Signatory:**   
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RF Operations Leader, Radio Laboratory



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**UL International (UK) LTD**

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Telephone: +44 (0)1256 312000

## **Customer Information**

<b>Company Name:</b>	Raspberry Pi LTD
<b>Address:</b>	Maurice Wilkes Building, St. John's Innovation Park, Cambridge, CB4 0DS, United Kingdom

## **Report Revision History**

<b>Version Number</b>	<b>Issue Date</b>	<b>Revision Details</b>	<b>Revised By</b>
1.0	13/09/2023	Initial Version	Ben Mercer
2.0	13/10/2023	Admin update	Ben Mercer
3.0	17/10/2023	FVIN removed	Ben Mercer

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## **1 Attestation of Test Results**








### **1.1 Description of EUT**

The equipment under test was a single board computer with *Bluetooth*, 2.4 GHz WLAN and 5 GHz WLAN transceivers.

### **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: 685609, 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, G24 8AH, United Kingdom
<b>Test Dates:</b>	05 June 2023 to 07 June 2023

### **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	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(b)(3)	RSS-Gen 6.12 / RSS-247 5.4(d)	Transmitter Maximum Peak Output Power	
Part 15.247(e)	RSS-247 5.4(b)	Transmitter Power Spectral Density	Note 1
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. In accordance with ANSI C63.10 Section 11.10.1, PSD measurements are not required if the maximum conducted output power is less than the PSD limit of 8 dBm / 3 kHz. The PSD level is therefore deemed to be equal to the measured output power.

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

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

## **2 Summary of Testing**

### **2.1 Facilities and Accreditation**

The test site and measurement facilities used to collect data are located at Unit 3 Horizon, Wade Road, Kingsland Business Park, Basingstoke, Hampshire, RG24 8AH, United Kingdom. The following table identifies which facilities were utilised for radiated emission measurements documented in this report. Specific facilities are also identified in the test results sections.

Site 1	X
Site 2	-
Site 17	X

UL International (UK) Ltd is accredited by 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”.

<b>Measurement Type</b>	<b>Range</b>	<b>Confidence Level (%)</b>	<b>Calculated Uncertainty</b>
Duty Cycle	2.4 GHz to 2.4835 GHz	95%	±1.14 %
99% Occupied 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%	±2.94 dB
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 25 GHz	95%	±3.16 dB

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

## **2.4 Test and Measurement Equipment**

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

<b>Asset No.</b>	<b>Instrument</b>	<b>Manufacturer</b>	<b>Type No.</b>	<b>Serial No.</b>	<b>Date Calibration Due</b>	<b>Cal. Interval (Months)</b>
M2071	Thermohygrometer	Testo	608-H1	45258132	08 Dec 2023	12
M231908	Signal Analyser	Keysight	N9020B	MY63430180	20 Dec 2023	12
A220120	Attenuator	Pasternack	PE7013-10	#1	Calibrated before use	-
M215596	Power Sensor	Boonton	RTP5008	11819	24 Mar 2024	12
231995	Switching Unit	Mini-Circuits	ZT-400	12211020020	Calibrated before use	-
E235134	Environmental Chamber	Espec	PU-1J	15020642	Calibrated before use	-
M226925	Thermometer	Fluke	52II	51980008WS	25 Oct 2023	12
M1725	Network Analyser	Keysight	E5071C	MY46316169	09 Nov 2023	12

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

<b>Name</b>	<b>Version</b>	<b>Release Date</b>
Phoenix Unlicensed	1.0.18 beta 11	05/06/2023



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

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2003	Thermohygrometer	Testo	608-H1	45046641	09 Dec 2023	12
K0017	3m RSE Chamber	MVG Industries UK Ltd.	N/A	N/A	08 Nov 2023	12
M1995	Test Receiver	Rohde & Schwarz	ESU40	100428	02 Nov 2023	12
A2863	Pre-Amplifier	Keysight Technologies Inc	8449B	3008A02100	07 Nov 2023	12
A2889	Horn Antenna	Schwarzbeck	BBHA 9120 B	00653	02 Nov 2023	12
A2916	Attenuator	AtlanTecRF	AN18W5-10	832827#2	25 Jan 2024	12
A2914	High Pass Filter	AtlanTecRF	AFH-03000	2155	25 Jan 2024	12
A2890	Horn Antenna	Schwarzbeck	HWRD 750	014	02 Nov 2023	12
A223628	Pre-Amplifier	Atlantic Microwave	A-LNAKX-380116-S5S5	210837001	03 Nov 2023	12
A2947	High Pass Filter	AtlanTecRF	AFH-07000	1601900001	25 Jan 2024	12
A3265	Pre-Amplifier	Schwarzbeck	BBV 9721	9721-069	31 Oct 2023	12
A2892	Horn Antenna	Schwarzbeck	BBHA 9170	9170-727	31 Oct 2023	12
M2040	Thermohygrometer	Testo	608-H1	45124934	09 Dec 2023	12
K0001	3m RSE Chamber	MVG Industries UK Ltd.	N/A	N/A	05 Sep 2023	12
M236226	Test Receiver	Rohde & Schwarz	ESW26	103134	21 Apr 2024	12
A3165	Loop Antenna	ETS-Lindgren	6502	00224383	13 Apr 2024	12
A3036	Low Pass Filter	AtlanTecRF	AFL-02000	15062902848	25 Jan 2024	12
A3167	Pre-Amplifier	Com-Power Corporation	PAM-103	18020010	02 Nov 2023	12
A2148	Attenuator	Atlan TecRF	AN18-06	090202-06	06 Oct 2023	12
A490	Bi-Log Antenna	Chase EMC Ltd	CBL6111A	1590	06 Oct 2023	12

**Test Equipment Used for Transmitter Band Edge Radiated Emissions Tests**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2003	Thermohygrometer	Testo	608-H1	45046641	09 Dec 2023	12
K0017	3m RSE Chamber	MVG Industries UK Ltd.	N/A	N/A	08 Nov 2023	12
M1995	Test Receiver	Rohde & Schwarz	ESU40	100428	02 Nov 2023	12
A2863	Pre-Amplifier	Keysight Technologies Inc	8449B	3008A02100	07 Nov 2023	12
A2889	Horn Antenna	Schwarzbeck	BBHA 9120 B	00653	02 Nov 2023	12
A2916	Attenuator	AtlanTecRF	AN18W5-10	832827#2	25 Jan 2024	12

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

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

<b>Brand Name:</b>	Raspberry Pi
<b>Model Name or Number / HVIN:</b>	V2.0
<b>PMN:</b>	Raspberry Pi 5
<b>Test Sample Serial Number:</b>	C9 ( <i>Conducted sample #1</i> )
<b>Hardware Version:</b>	V2.0
<b>Software Version:</b>	V1.0
<b>FCC ID:</b>	2ABCB-RPI5
<b>ISED Canada Certification Number:</b>	IC: 20953-RPI5

<b>Brand Name:</b>	Raspberry Pi
<b>Model Name or Number / HVIN:</b>	V2.0
<b>PMN:</b>	Raspberry Pi 5
<b>Test Sample Serial Number:</b>	R29 ( <i>Radiated sample #1</i> )
<b>Hardware Version:</b>	V2.0
<b>Software Version:</b>	V1.0
<b>FCC ID:</b>	2ABCB-RPI5
<b>ISED Canada Certification Number:</b>	IC: 20953-RPI5

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

No modifications were applied to the EUT during testing.

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

<b>Technology Tested:</b>	<i>Bluetooth</i> Low Energy (Digital Transmission System)		
<b>Type of Unit:</b>	Transceiver		
<b>Channel Spacing:</b>	2 MHz		
<b>Modulation:</b>	GFSK		
<b>Data Rate: LE</b>	1 Mbps		
<b>Power Supply Requirement(s):</b>	Nominal	5.1 VDC	
<b>Maximum Conducted Output Power:</b>	4.67 dBm		
<b>Transmit Frequency Range:</b>	2402 MHz to 2480 MHz		
<b>Transmit Channels Tested:</b>	<b>Channel ID</b>	<b>Channel Number</b>	<b>Channel Frequency (MHz)</b>
	Bottom	37	2402
	Middle	17	2440
	Top	39	2480

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

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

<b>Frequency Range (MHz)</b>	<b>Antenna Gain (dBi)</b>
2400-2480	3.50

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

#### **Support Equipment**

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

<b>Description:</b>	Laptop
<b>Brand Name:</b>	Lenovo
<b>Model Name or Number:</b>	L480
<b>Serial Number:</b>	PF1EJ3BY

<b>Description:</b>	AC to DC USB-C Power Supply
<b>Brand Name:</b>	Raspberry Pi
<b>Model Name or Number:</b>	KSA-15E-051300HK
<b>Serial Number:</b>	Not Marked or Stated

<b>Description:</b>	Docking Station
<b>Brand Name:</b>	Lenovo
<b>Model Name or Number:</b>	40AT
<b>Serial Number:</b>	ZAFOLGYW

<b>Description:</b>	USB-A Cables. Qty 4. 1.5m
<b>Brand Name:</b>	Not Marked or Stated
<b>Model Name or Number:</b>	Not Marked or Stated
<b>Serial Number:</b>	Not Marked or Stated

<b>Description:</b>	Mini HDMI to HDMI Cables. Qty 2. 1.5m
<b>Brand Name:</b>	Raspberry Pi
<b>Model Name or Number:</b>	Not Marked or Stated
<b>Serial Number:</b>	Not Marked or Stated

<b>Description:</b>	Ethernet Cable. 3m
<b>Brand Name:</b>	Not Marked or Stated
<b>Model Name or Number:</b>	Not Marked or Stated
<b>Serial Number:</b>	Not Marked or Stated

## **Operating Modes**

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

- Transmitting at maximum power in *Bluetooth* LE mode with modulation, maximum possible data length available and Pseudorandom Bit Sequence 9.

## **Configuration and Peripherals**

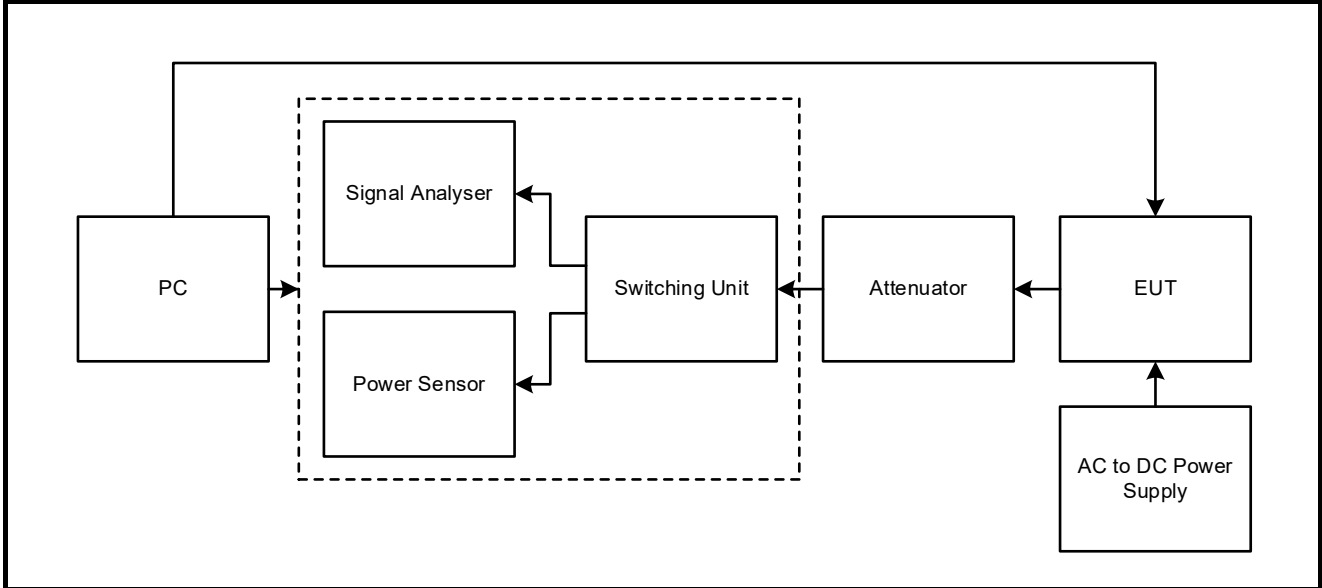
The EUT was tested in the following configuration(s):

- The customer's test application and supplied instructions were used to place the EUT into Bluetooth LE test mode. The supplied commands were entered into the console menu on the EUT. Test commands stated in the BT\_Commands.txt file located on the /home/pi drive of the EUT were used to configure the EUT to enable a continuous transmission and to select the test channels as required.
- The EUT was powered from an AC to DC USB-C Power Supply. The input was connected to a 120 VAC 60 Hz single phase mains supply.
- Transmitter radiated spurious emissions tests were performed with the EUT in the worst-case orientation with respect to emissions. The Ethernet port was terminated into a test laptop via an Ethernet cable. The test laptop was placed in the antechamber. The 2 HDMI ports and 4 USB ports were terminated into a docking station via HDMI and USB cables. The docking station was placed under the turntable.

**Test Setup Diagrams**

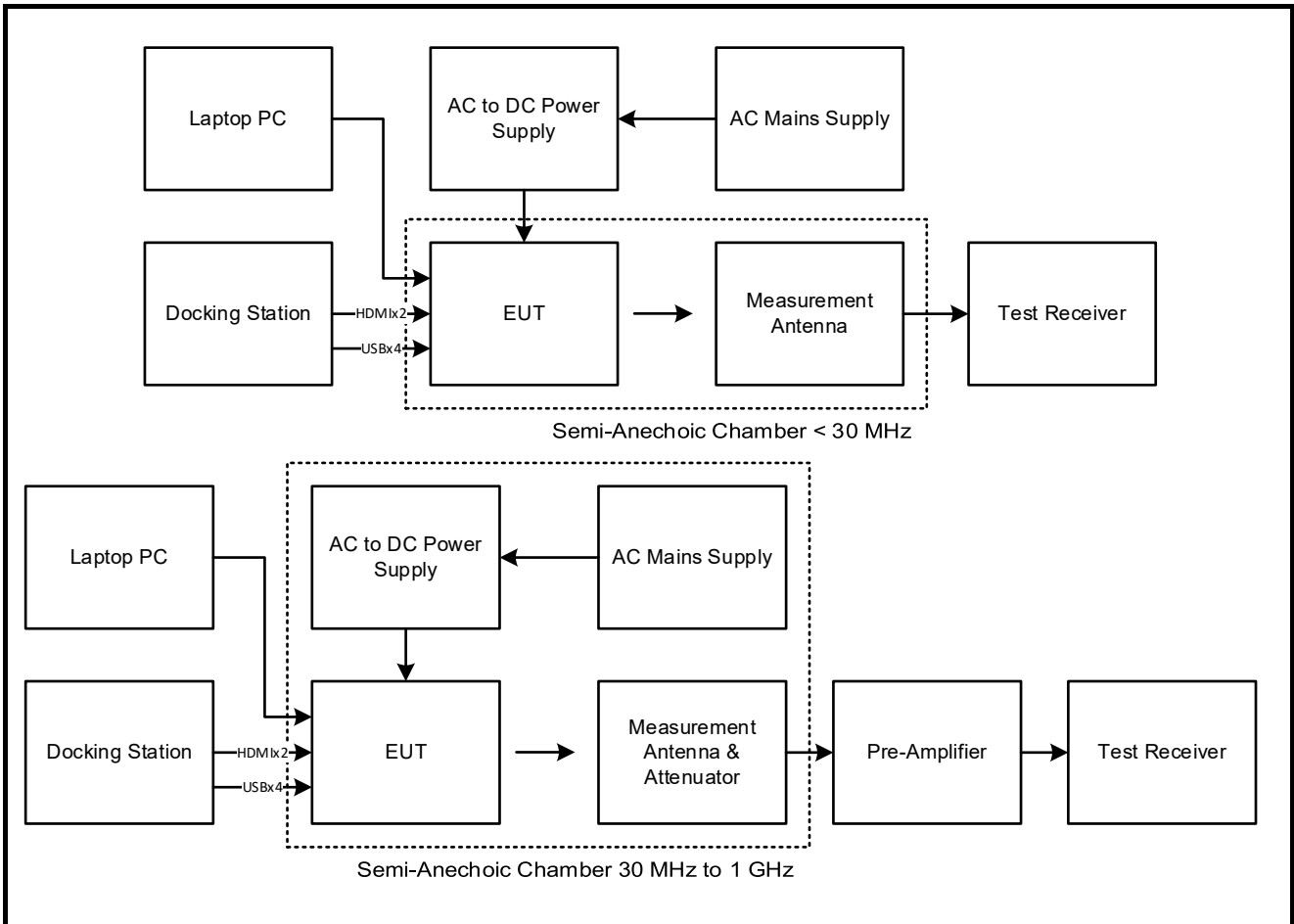
**Conducted Tests:**

**Test Setup for Transmitter Conducted Tests**



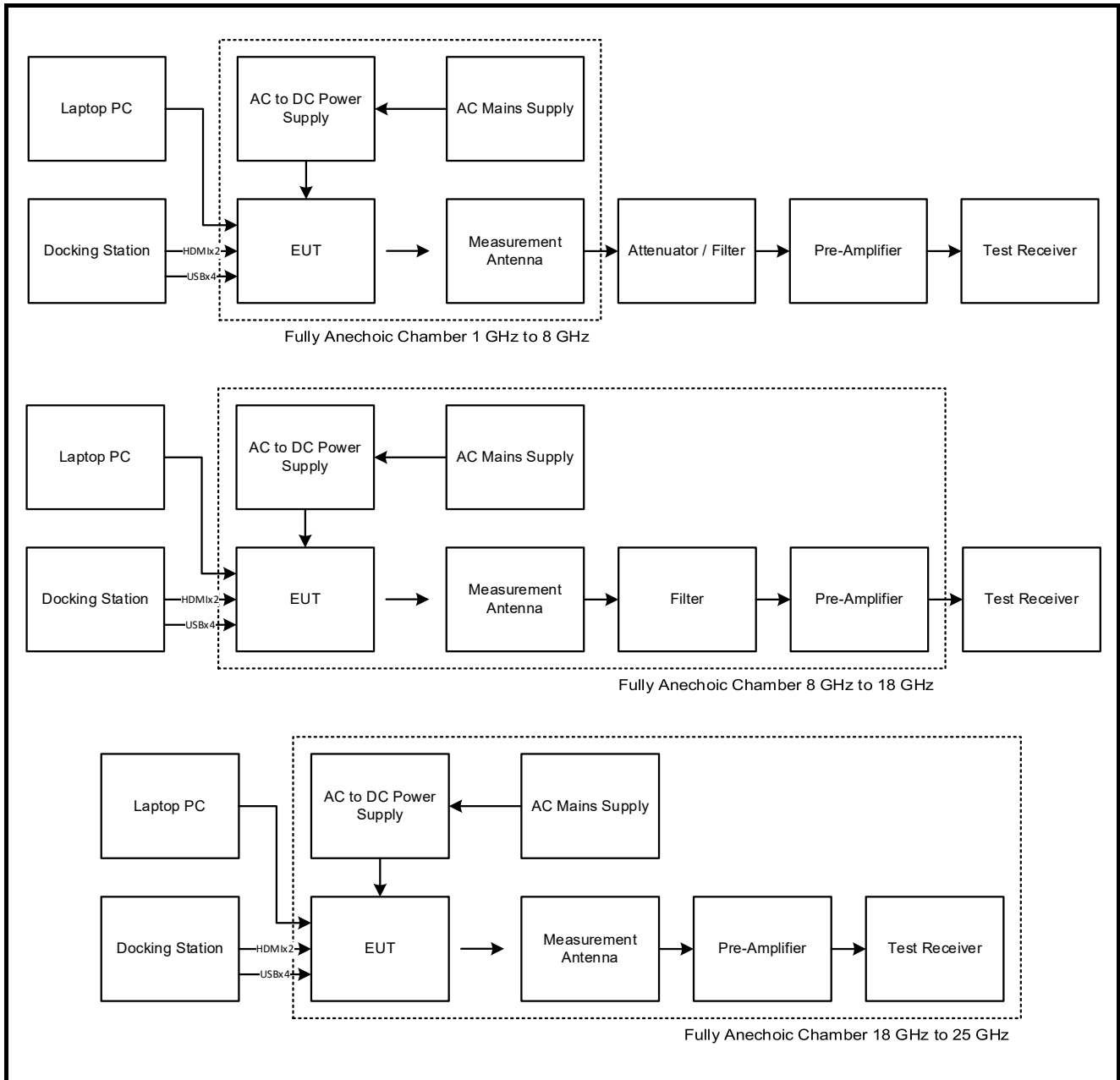
**Radiated Tests:**

**Test Setup for Transmitter Radiated Emissions**



**Test Setup Diagrams (continued)**

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



## **4 Antenna Port Test Results**

### **4.1 Transmitter 99% Occupied Bandwidth**

#### **Test Summary:**

<b>Test Engineer:</b>	Luis Pazos Perez	<b>Test Date:</b>	05 June 2023
<b>Test Sample Serial Number:</b>	C9		

#### **Environmental Conditions:**

<b>Temperature (°C):</b>	23
<b>Relative Humidity (%):</b>	50

#### **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. The span was set to capture all products of the modulation process including emission skirts.
2. 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 4 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 test system was connected to the RF port on the EUT using suitable attenuation and RF cable.



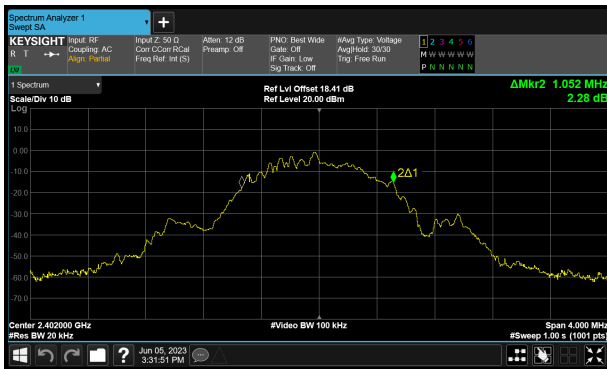
**Transmitter 99% Occupied Bandwidth (continued)**

**Results:**

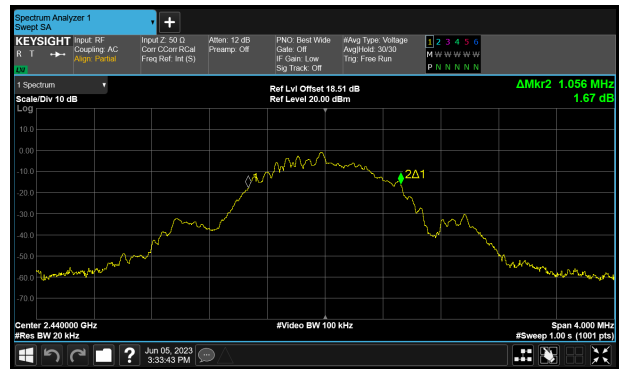
<b>Frequency Range:</b>	2400-2483.5 MHz	<b>Band:</b>	2.4 GHz
<b>Limit Clause(s):</b>	RSS-Gen 6.7	<b>Test Method(s):</b>	C63.10 6.9.3

<b>Antenna Configuration:</b>	SISO	<b>Mode:</b>	LE1M
<b>Test Port:</b>	1 (BT1)	<b>Modulation/Rate:</b>	GFSK

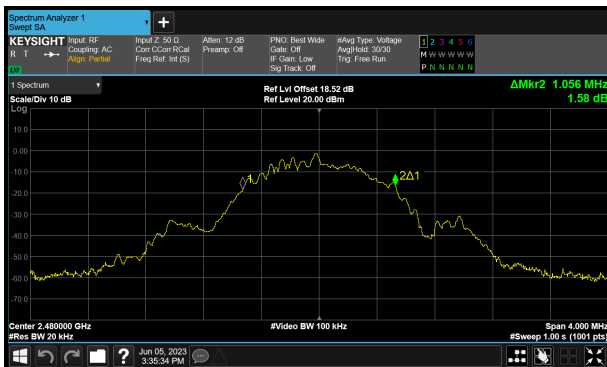
Test Frequency (MHz)	99% Bandwidth (MHz)				Limit (kHz)
	1	2	3	4	
2402 (CH37)	1.052	-	-	-	-
2440 (CH17)	1.056	-	-	-	-
2480 (CH39)	1.056	-	-	-	-



**BT1 (1) 2402 MHz (CH37) 99% Bandwidth**



**BT1 (1) 2440 MHz (CH17) 99% Bandwidth**



**BT1 (1) 2480 MHz (CH39) 99% Bandwidth**

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

### **Test Summary:**

<b>Test Engineer:</b>	Luis Pazos Perez	<b>Test Date:</b>	05 June 2023
<b>Test Sample Serial Number:</b>	C9		

### **Environmental Conditions:**

<b>Temperature (°C):</b>	23
<b>Relative Humidity (%):</b>	50

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

1. 6 dB DTS bandwidth tests were performed using a signal analyser in accordance with ANSI C63.10 Section 11.8.1 Option 1 measurement procedure. The signal analyser resolution bandwidth was set to 100 kHz and video bandwidth 300 kHz. A peak detector was used, sweep time was set to auto and the trace mode was Max Hold. The DTS bandwidth was measured at 6 dB down from the peak of the signal.
2. The test system was connected to the RF port on the EUT using suitable attenuation and RF cable.

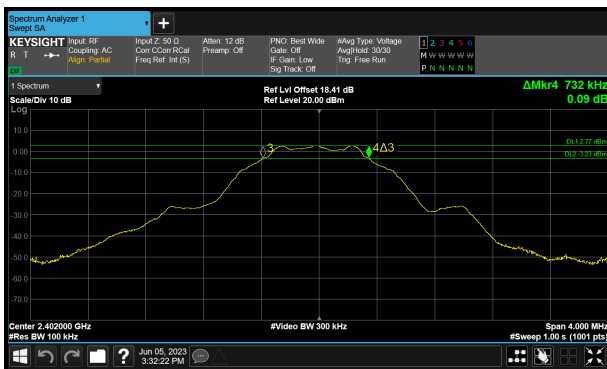
**Transmitter Minimum 6 dB Bandwidth (continued)**

**Results:**

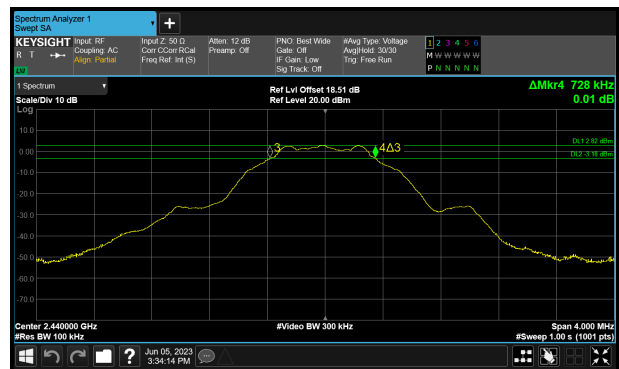
<b>Frequency Range:</b>	2400-2483.5 MHz	<b>Band:</b>	2.4 GHz
<b>Limit Clause(s):</b>	15.247 (a)(2) RSS-247 5.2 a)	<b>Test Method(s):</b>	C63.10 11.8.1

<b>Antenna Configuration:</b>	SISO	<b>Mode:</b>	LE1M
<b>Test Port:</b>	1 (BT1)	<b>Modulation/Rate:</b>	GFSK

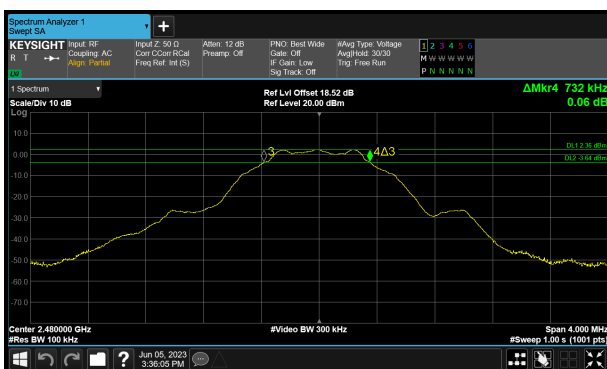
Test Frequency (MHz)	6 dB Bandwidth (MHz)				Limit (kHz)
	1	2	3	4	
2402 (CH37)	0.732	-	-	-	>500
2440 (CH17)	0.728	-	-	-	>500
2480 (CH39)	0.732	-	-	-	>500



**BT1 (1) 2402 MHz (CH37) 6 dB Bandwidth**



**BT1 (1) 2440 MHz (CH17) 6 dB Bandwidth**



**BT1 (1) 2480 MHz (CH39) 6 dB Bandwidth**

### 4.3 Transmitter Maximum Peak Output Power

#### Test Summary:

Test Engineer:	Luis Pazos Perez	Test Date:	05 June 2023
Test Sample Serial Number:	C9		

#### Environmental Conditions:

Temperature (°C):	21
Relative Humidity (%):	41

#### Note(s):

1. Conducted power tests were performed using a peak power meter in accordance with ANSI C63.10 Section 11.9.1.3 with the PKPM1 peak power meter method.
2. The test system was connected to the RF port on the EUT using suitable attenuation and RF cable. An RF level offset was entered on the test system to compensate for the loss of the attenuator and RF cable.
3. The conducted power was added to the declared antenna gain to obtain the EIRP.

#### Results:

Frequency Range:	2400-2483.5 MHz	Band:	2.4 GHz
Limit Clause:	15.247 (b)(3) RSS-247 5.4 d)	Test Method:	C63.10 11.9.1.3

Antenna Configuration:	SISO	Mode:	LE1M
Test Port:	1 (BT1)	Modulation/Rate:	GFSK

Burst Tx	Stability: < ±2%	Duty Cycle (%): 62.44	Period (ms): 0.625	Width (ms): 0.390
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Test Frequency (MHz)	Maximum Conducted Output Power (dBm)					Limit (dBm)	Margin (dB)	Gain (dBi)	EIRP (dBm)	EIRP Limit (dBm)	EIRP Margin (dB)
	1	2	3	4	Σ						
2402 (CH37)	4.67	-	-	-	-	30.00	25.33	3.50	8.17	36.00	27.83
2440 (CH17)	4.57	-	-	-	-	30.00	25.43	3.50	8.07	36.00	27.93
2480 (CH39)	4.07	-	-	-	-	30.00	25.93	3.50	7.57	36.00	28.43

## **5 Radiated Test Results**

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

#### **Test Summary:**

<b>Test Engineers:</b>	John Ferdinand & Robert English	<b>Test Date:</b>	07 June 2023
<b>Test Sample Serial Number:</b>	R29		

<b>FCC Reference:</b>	Parts 15.247(d) & 15.209(a)
<b>ISED Canada Reference:</b>	RSS-Gen 6.13 & 8.9 / 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
<b>Relative Humidity (%):</b>	38 to 40

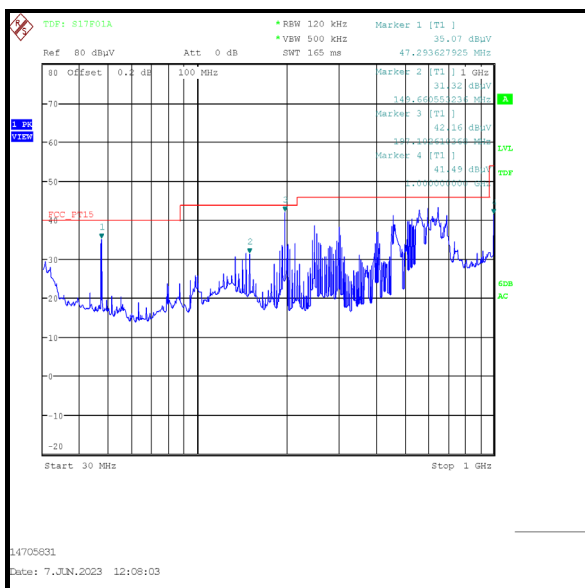
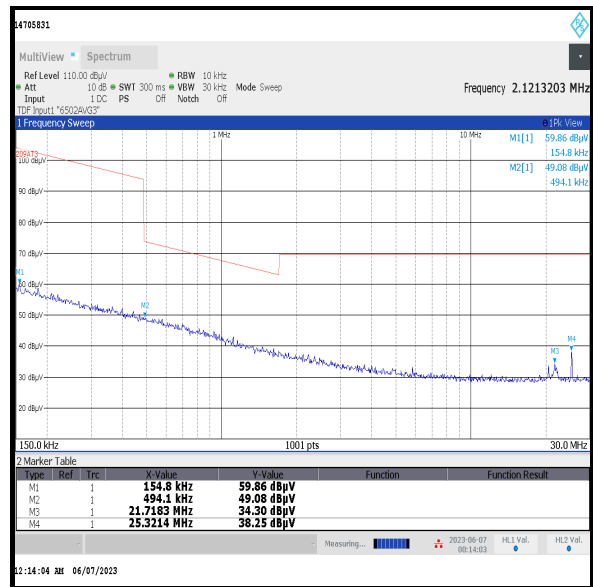
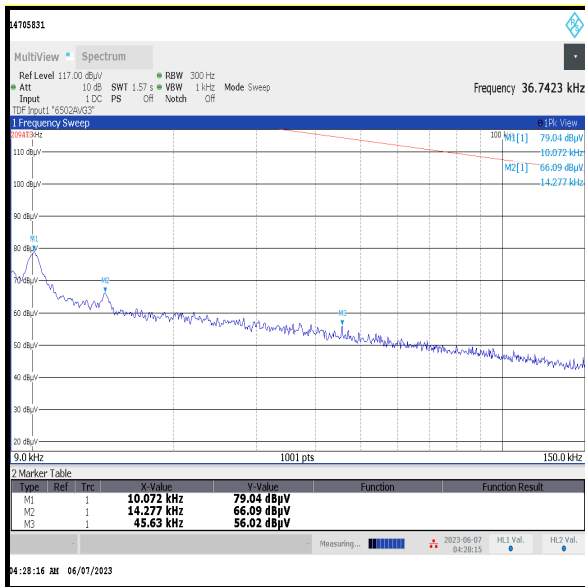
#### **Note(s):**

1. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
2. All other emissions shown on the pre-scans were investigated and found to be ambient, >20 dB below the appropriate limit or below the noise floor of the measurement system.
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. Measurements below 1 GHz were performed in a semi-anechoic chamber (Asset Numbers K0017/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.
5. The limits in CFR 47, Part 15, Subpart C, paragraph 15.209 (a), are identical to those in RSS-Gen Section 8.9, Table 6, since the measurements are performed in terms of magnetic field strength and converted to electric field strength levels (as reported in the table) using the free space impedance of  $377\Omega$ . For example, the measurement frequency X kHz resulted in a level of Y dB $\mu$ V/m, which is equivalent to  $Y - 51.5 = Z$  dB $\mu$ A/m, which has the same margin, W dB, to the corresponding RSS-Gen Table 6 limit as it has to the 15.209(a) limit.
6. 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.
7. Final measurements were performed on the marker frequencies and the results entered into the table below. The test receiver resolution bandwidth was set to 120 kHz, using a CISPR quasi-peak detector and span wide enough to see the whole emission.

**Transmitter Radiated Emissions (continued)**

**Results: Quasi-Peak / Middle Channel**

Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
149.679	Horizontal	31.5	43.0	11.5	Complied
248.392	Horizontal	36.5	46.0	9.5	Complied
252.148	Horizontal	34.4	46.0	11.6	Complied
405.831	Vertical	35.9	46.0	10.1	Complied
607.191	Horizontal	36.6	46.0	9.4	Complied
999.003	Vertical	39.3	54.0	14.7	Complied



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

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

### **Test Summary:**

<b>Test Engineer:</b>	John Ferdinand	<b>Test Dates:</b>	05 June 2023 & 06 June 2023
<b>Test Sample Serial Number:</b>	R29		

<b>FCC Reference:</b>	Parts 15.247(d) & 15.209(a)
<b>ISED Canada Reference:</b>	RSS-Gen 6.13 & 8.9 / RSS-247 5.5
<b>Test Method Used:</b>	FCC KDB 558074 Sections 8.1 c)3), 8.5 & 8.6 referencing ANSI C63.10 Sections 6.3, 6.6, 11.11 & 11.12
<b>Frequency Range</b>	1 GHz to 25 GHz

### **Environmental Conditions:**

<b>Temperature (°C):</b>	23 to 24
<b>Relative Humidity (%):</b>	36 to 38

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

1. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
2. All other emissions shown on the pre-scans were investigated and found to be ambient, >20 dB below the appropriate limit or below the noise floor of the measurement system.
3. The emission shown on the 1 GHz to 3 GHz plot is the EUT fundamental.
4. \*In accordance with ANSI C63.10 Section 6.6.4.3, Note 1, if the peak measured value complies with the average limit, it is unnecessary to perform an average measurement.
5. Pre-scans 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. All measurement antennas were placed at a fixed height of 1.5 metres above the test chamber floor, in line with the EUT.
6. Final measurements above 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 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.
7. 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 respective detectors.

**Results: Bottom Channel / Peak**

Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
3843.002	Vertical	47.9	54.0*	6.1	Complied
18799.660	Vertical	46.4	54.0*	7.6	Complied
19979.988	Vertical	42.5	54.0*	11.5	Complied

**Results: Middle Channel / Peak**

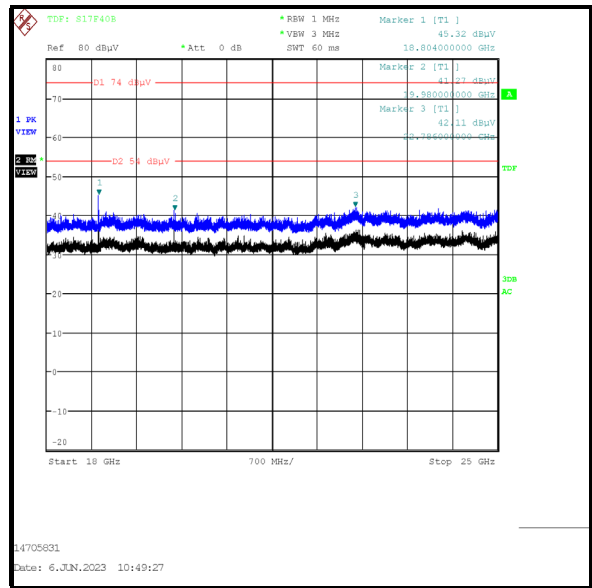
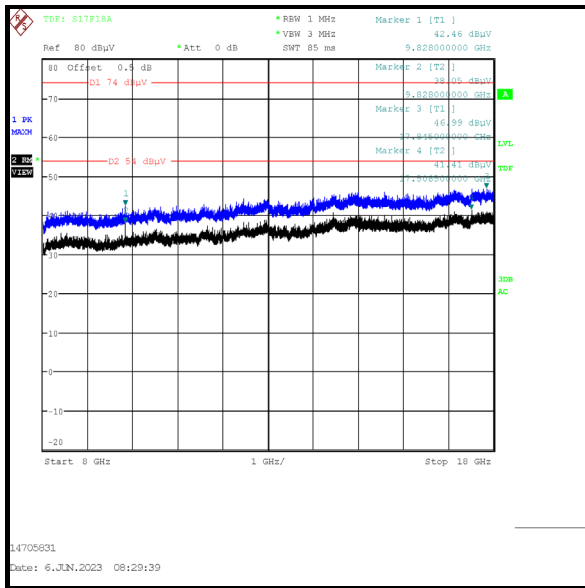
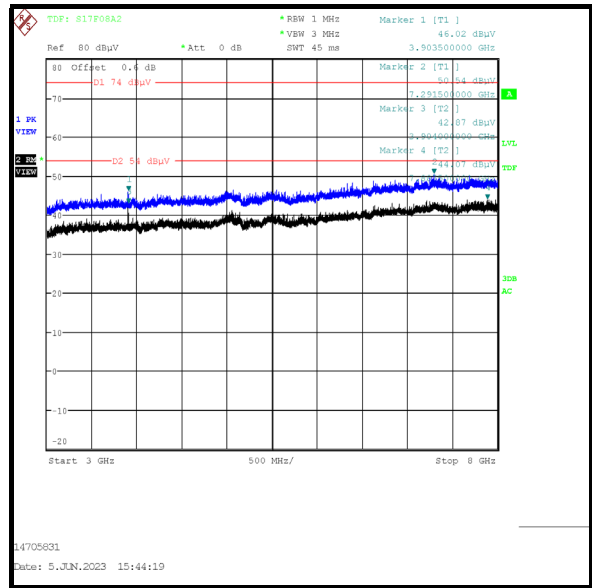
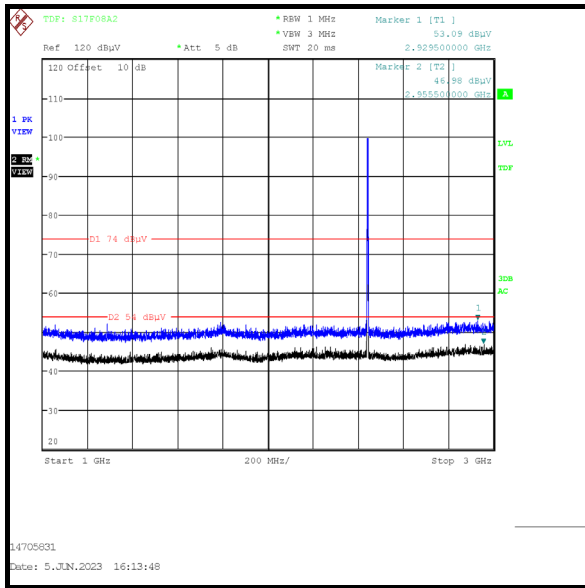
Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
3903.838	Vertical	47.0	54.0*	7.0	Complied
18799.660	Vertical	46.4	54.0*	7.6	Complied
19979.988	Vertical	42.5	54.0*	11.5	Complied

**Results: Top Channel / Peak**

Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
3967.964	Vertical	47.0	54.0*	7.0	Complied
18799.660	Vertical	46.4	54.0*	7.6	Complied
19979.988	Vertical	42.5	54.0*	11.5	Complied



**Transmitter Radiated Emissions (continued)**



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

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

#### **Test Summary:**

<b>Test Engineer:</b>	John Ferdinand	<b>Test Date:</b>	05 June 2023
<b>Test Sample Serial Number:</b>	R29		

<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>	KDB 558074 Section 8.7 referencing ANSI C63.10 Sections 11.11, 11.12 & 11.13

#### **Environmental Conditions:**

<b>Temperature (°C):</b>	24
<b>Relative Humidity (%):</b>	36

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

1. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
2. 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 11.11.3 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 peak conducted output power was measured using an peak detector in accordance with ANSI C63.10 Section 11.9.1.1 an out-of-band limit line was placed 20 dB (ANSI C63.10 Section 11.11.1(a)) below the peak level. A marker was placed on the band edge spot frequencies. Marker frequency 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 Max Hold. 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 peak and RMS detectors respectively. Markers were placed on the highest point on each trace.
5. \* -20 dBc limit.

**Transmitter Band Edge Radiated Emissions (continued)****Results: Peak**

Frequency (MHz)	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2397.917	44.7	77.3*	32.6	Complied
2400.000	43.8	77.3*	33.5	Complied
2483.500	51.1	74.0	22.9	Complied
2483.821	53.0	74.0	21.0	Complied

**Results: Average**

Frequency (MHz)	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2483.500	47.1	54.0	6.9	Complied
2483.901	47.9	54.0	6.1	Complied

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

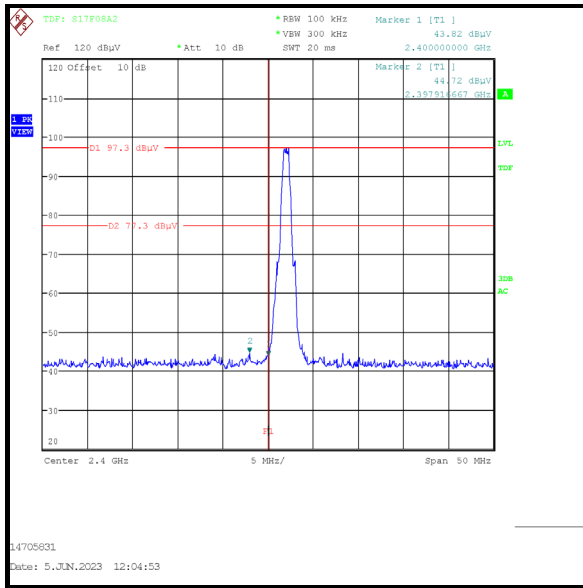
Frequency (MHz)	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2349.103	54.4	74.0	19.6	Complied

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

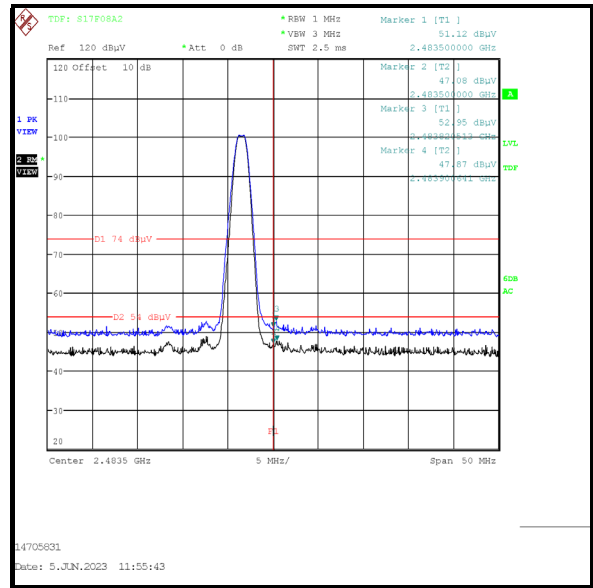
Frequency (MHz)	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2388.590	49.1	54.0	4.9	Complied

### Transmitter Band Edge Radiated Emissions (continued)

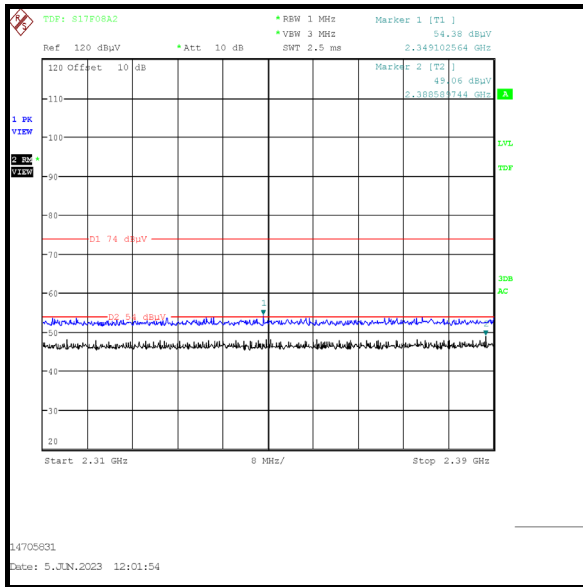
#### Results:



Lower Band Edge



Upper Band Edge



2310 MHz to 2390 MHz Restricted Band

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